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Centrifugal Grease Extractor.

With this we give two illustrations of a new grease extractor used for extracting the oil from the exhaust steam as it passes from the cylinder of the engine to the condenser. An outside view of the extractor is given above the pump in Fig. 1, and a section of it in Fig. 2.

The extractor consists of a shell or casing in which there is firmly secured a stationary double-ended cone. On this cone there are cast a number of knife-edged wings, extending spirally along its exterior; the area of the annular space between the cone and the shell of the extractor is equal at its smallest cross-section to that of the steam pipe, from whence it is greatly enlarged. At the outlet end of the shell there is also an annular space formed by an inverted outlet pipe.

On entering the separator the steam is spread and thrown outward by the cone, and given a centrifugal motion by the spiral wings. These wings are constructed with curved surfaces tangential to the cone, which is an important factor in the construction of the extractor, as it materially aids in producing an outward flow to the water and grease, etc.

Steam on entering the extractor is immediately expanded from a solid volume (due to the size of the pipe) into an annular space of equal volume, whereby its particles are removed farther from the center, and thereby can receive a greater amount of centrifugal force.

Under these favorable conditions the entrained water, grease, etc., meet curved, angular wings, along which they flow outward to the shell of the extractor, and are collected in a well shown below the extractor. Here they are entirely isolated from the flow of dry steam which passes off through the inverted pipe.

From this well the oil and water are drawn by the steam pump, which works automatically. The oil and water enter into a V-shaped chamber at the bottom of the large elbow; at the top of this V-chamber a screen is fixed which prevents any grit or foreign substances from entering the pump. As the water and oil rise a cylindrical float is lifted, its stem is connected to a horizontal lever which opens two small poppet valves shown at the top of the elbow. The opening of these valves allows the escape of the exhaust steam from the pump which is returned to extractor as shown in Fig. 1; this starts the pump and draws the oil and water through the connection *D*, and delivers them into any desirable place.

For cleaning the elbow and the V-chamber underneath, the steam valve *E*, the exhaust valve *B*, and the valve *D* are closed, and the small poppet valves at the top of the elbow are opened by the lever shown at the left of the vertical branch of the elbow, the by-pass valve *A* is then opened, allowing the live steam to enter the elbow and forcing all the grit and foreign substances through the connection *C*. In the whole of this arrangement there are no stuffing boxes, the absence of which will greatly promote cleanliness around the pump.

The inventor also intends to use this pump (of course without the extractor) in buildings heated by steam. In cases of this kind the water due to condensation is collected in the elbow from which it is returned into the boiler, by the same automatic arrangement as described above. These extractors and pumps are built by Jos. De Rycke, 39 Cortlandt street, New York.

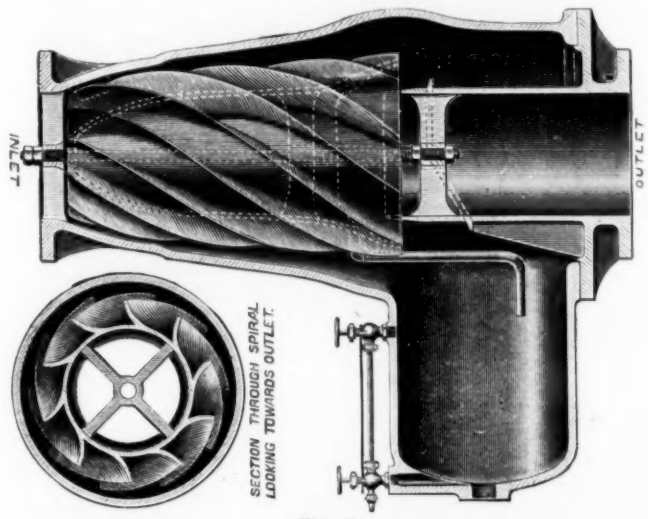
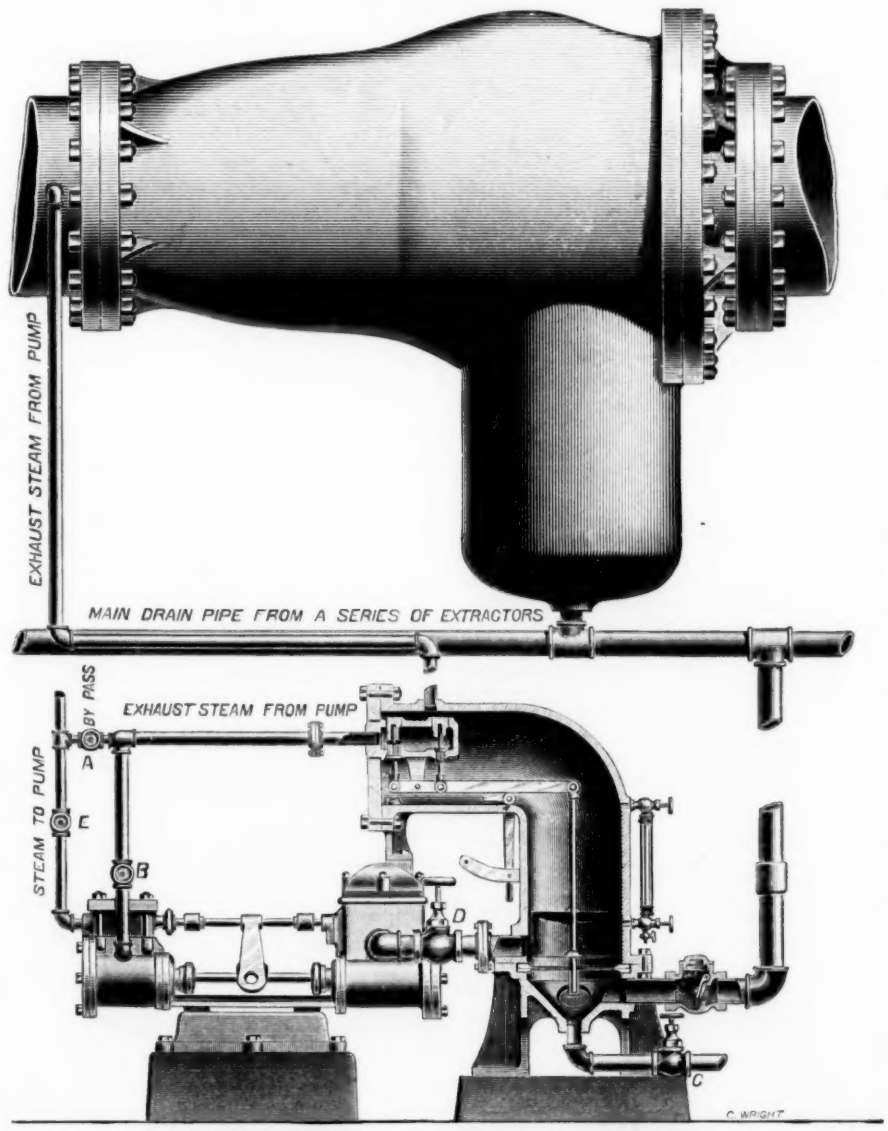


Fig. 2.



CENTRIFUGAL GREASE EXTRACTOR.—FIG. 1.

109 in Brooklyn and 89 in Philadelphia, we think, is the trolley slaughter record to date, but speed has been much reduced in Brooklyn and the death rate is lower.

Working Stock in Drop Dies.

BY B. F. SPALDING.

A considerable part of the expense incurred in the production of drop forgings is the cost of the dies in which the work is shaped. The proportion which this expense bears to the cost of a certain number of forgings depends upon the durability of the dies. When the making of the forgings is a permanent business and they are in constant demand in such numbers as requires the renewal of the dies from time to time, the proportionate cost of maintaining the dies in good condition is sometimes insignificant and sometimes important.

There are circumstances under which the cost of dies must be noticed. It is often expedient to make drop forgings in order to obtain the advantage of the uniformity which the dies give them, although the number of forgings required may be so small that the dies need not be much worn when the entire amount of forgings has been made, but in this instance, as in every other, it is for obvious reasons very desirable to have the dies retain their original perfection so far as possible. In such cases the cost of the dies is a large factor in the cost of the work. It is best to keep them, for there is always a possibility that they may be needed again.

When it becomes evident that a large number of pieces is to be made, and that the tools for making them will require frequent renewal, it becomes a matter of economy to provide reasonable facilities for the reproduction of these tools, and also to fix the methods which shall be adopted for the use of the tools so as to insure their utmost effectiveness and durability, and restrict within the narrowest limits the expenses of profitless manufacture. On drop work, for instance, it is to be determined what sized drop shall be used, and how many blows shall be struck at each operation. Drop dies therefore come well within the scope of the rule. They are quite expensive in both material and workmanship, and are often subjected to the handling of piece workmen who are naturally a good deal more interested in getting all they can out of them, in the shortest possible time, than they are in their preservation.

It is true that drop hammer men soon become shrewd enough, as a general thing, to know that the better care they take of their dies, the easier and more freely they will work, but as they stand with a piece of work in the die, which is not quite filled out with the blows already struck upon it, there is but an instant afforded them in which to decide whether it is best to give the cooling piece one blow more without reheating, and in that critical moment they are liable to be overcome by a surge of self-interest, and decide to hit it again and risk the die.

A hot piece of iron might lie loosely in the impression of a die until it cooled. It could become cold without heating the corners around the impression enough to seriously affect their temper; but it is quite a different thing when the hot iron has already been struck with such force as to bring it into more intimate contact with the steel of the die than its own grains have with each other, for the steel has the heat absolutely forced into it when an additional blow is given. If this will not draw the temper, nothing will, and if the corner of the impression is already almost red hot, then the additional blow, driving down on an almost cold fin, will drive down the corner, and make it overhang and hug the work so that it will be hard to disengage it from the die. Then the good hammer man, if he is not unmind-

ful of the future, will have the die fixed before it gets any worse, but if his temper rises when that of the die falls he will continue to devil with the die until his work sticks so bad that, in removing it, it gets out of shape so much as to damage it. Then he will have the die repaired.

A drop man says it is more exacerbating to have the work stick in the upper die than in the lower one, especially if the drop is working on a high stroke. His work is pulled out of his grasp in spite of his most energetic efforts to retain it. He relates that he was amused a short time ago to hear a fellow, who was thus bothered, vent his feelings by exclaiming to his bewitched work as it went upward, "Oh, you're going to be an angel, ain't ye?". Sticking in the upper die is so troublesome that it is generally relieved as soon as possible.

As a general rule it is better for the dies to have the blow of the drop struck on the hot material with force enough to fill them at the first stroke without allowing it to remain in them for a repetition of the blow. This would often require a heavier drop hammer than is available. There are some objections to using heavy drops, among which, that very palpable one of first cost is generally effectual.

There is another which demands consideration, and that is, the effect which the sudden application of power to raise a heavy weight has upon the shafting and carries back in some measure toward the prime motor, diffusing itself and being absorbed, partly, among the revolving pulleys and shafts and running belts until its last vibration is taken up by the fly wheel.

There are some other objections also, and it therefore becomes a question whether it is better, when all things are taken into consideration, to have a drop heavy enough to make the piece at one blow, or to strike it two or more.

In this consideration the fact must not be neglected that whether a heavy drop is lifted one foot to strike a light blow, or five feet to strike a heavy blow, the application of power, required to give it its first impulse upward, is as great in one case as in the other, and therefore the effect of shock upon the motive power and its appliances is less when light blows are struck with light drops than when light blows are struck with heavy drops.

Leaving out of the question, however, everything but the especial economy of the dies, it is better to finish at one blow all the work the dies have to perform at each insertion of the hot piece. The dies will last longer when thus treated, the corners of the impressions will retain their original form longer than when the pieces are submitted to more blows before removing them from the dies.

The effect upon the work of striking one blow or more is a different question from that relating to the effect upon the dies, and to this question it must be replied that in a majority of instances the stock is bettered by being struck more than one blow. Action and reaction are equal, however much the attacked may retire before the advance. The falling die delivers its force, and the stock is driven into every recess into which it can rush, but there is reaction enough to stop the blow, and resiliency still in the struck mass, even if it has been strained beyond the bounds of complete recovery, and instantly—before the weight is lifted—the particles have recovered to some extent their lost positions, or have moved back towards them, and this repulsion leaves them with an open grain, and it is only by striking them, blow after blow, that the particles can be pressed into a close union which they will retain, each blow leaving them nearer until the stock is got into that condition when the force of the blow no longer strains them beyond the limit of elastic recovery.

This is the practical effect of "working" iron, and its benefits are more or less displayed on drop forgings in proportion to the number of blows which are effective up to the point of full efficiency. A greater blow than one that is efficient produces no more useful effect than one which is simply sufficient. A number of disturbances, from which the particles recover in different degrees, is necessary to produce close texture and the greatest amount of cohesion; in short, the best material.

Practically little regard is paid, as things go in shops where drops are used, to the effect which the working of the drop has upon the stock. In the olden time, when the blacksmith's soul was in his work, the art of working upon the anvil was not gauged by the amount of work that was thrown upon the floor, but somewhat, also, by the qualities which the manner of working the material conferred upon it. This is little considered now, for the reason that, as it is ordinarily worked, the material is abundantly good for all purposes for which it is used. If upon trial one brand of stock is found to be defective when worked in a certain manner, the manner of working is not changed, but another brand of stock is secured which will yield good results when worked in the manner adopted.

The increasing employment of bending machines has extended and rendered more imperative the necessity of securing stock which will stand the peculiar usage to which it is subjected in forming. A blacksmith can humor the peculiarities of any kind of iron or steel by his manner of working it upon the anvil, but a man who runs a machine which makes 600 or 900 strokes an hour, and is called upon to bend a piece of iron into a certain form at every stroke, has no time to fool away in humoring the proclivities of any kind of stock. He may favor it within reasonable limits by his manner of heating it, but when it is submitted to the action of the machine, the quality of mercy is strained to the breaking point and the stock must be of such a nature that it will take, without serious injury, the impression of the dies. One of the conspicuous results of these conditions is, frequently, the substitution of soft steel for pieces which might otherwise be made of iron.

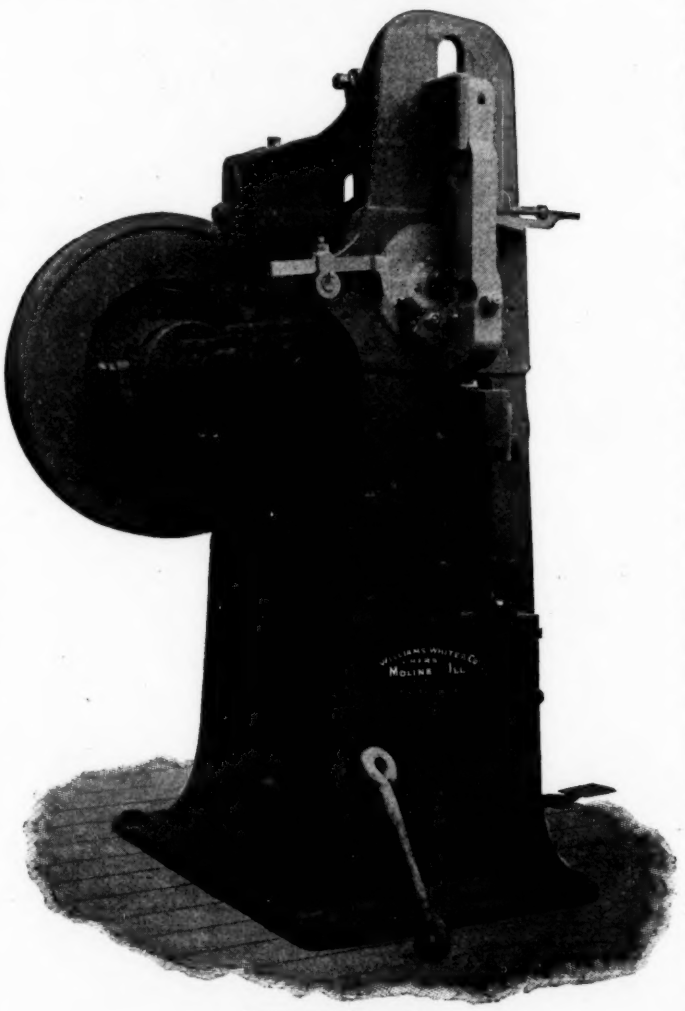
There is a distinction between the classes of work which are usually done under the drop, or in the bending machine. In the drop dies, the particles of stock are generally pressed together very closely, while the operation of bending tends to strain apart those on the outside of the bend. Most any kind of stock can be jammed into a hole in a drop die, but the bar bent on a bending machine must have some degree of tenacity, to bend without cracking.

Even cold shuts will close so completely in a drop die that they are undiscoverable until the piece is put to some stress which will disclose them. Due caution must therefore be exercised in devising drop processes, to adopt such as will insure sound forgings. Too much reliance must not be placed upon fair outsides.

Whenever it becomes necessary to place dependence upon uniting stock by welding in drop dies, it is the safest way to have the welding thoroughly done at the first blow. The parts which are forced forward to be united at the second blow, are liable to be dry, filmed over, and unweldable. It is to be observed that the necessary conditions for cold welding are not present in drop dies.

If two, or more, blows are to be struck on a piece at the same heat, in the same dies, it is a great relief to the dies to at least loosen the piece in the dies the instant they separate. This proceeding breaks that intimate contact between the hot piece and the die, which affords a bridge for the quick passage of the heat to the edges of the impression, which it softens and makes susceptible to injury. It does not require a wide separation to greatly weaken the conducting capacity of actual contact.

When it is found that drop forgings do not have the strength which they were calculated to possess, some revision should be made of the processes, and such corrections applied as may have a favorable effect. If the dies are properly devised and the work is carefully manipulated, the material in a drop forging can be brought to the highest degree of excellence which such stock is capable of possessing. The stock can be wrought in drop dies to its greatest perfection without much injury to the dies. Stock allowed to cool from a welding heat, with no work done upon it below that heat, is very far from being in its best condition.



EYEBOLT MACHINE.

An Eyebolt Machine.

We illustrate on this page an eyebolt machine made by Williams, White & Co., Moline, Ill. Such a machine would seem to be a desideratum in a well-equipped blacksmith shop having much of that class of work. The machine has a retreating gauge against which the iron is pushed, whereupon the machine grips it, forms it around the mandrel, releases it and withdraws the mandrel automatically. Below on the face of the machine is a shearing or welding form. Small sizes of iron, if hot enough, can be welded at the same stroke that forms them. The bending dies are small and inexpensive, and by shaping them to suit, and with the adjustment possible in the machine, almost any variety of hook or eye may be made in round, flat or square iron, this ready adaptability to various sizes and styles of eyebolts being a distinctive feature of the machine.

When a watch becomes magnetized by intimacy with a dynamo, the mainspring, being tempered, becomes a magnet, and, as it unwinds, its attraction, varying in direction or intensity, causes the rate of escapement to vary at different hours of the day.

Some Reminiscences of Frederick E. Sickels.

BY ONE OF THE ENGINEERS OF THE "PENSACOLA."

No engineer of the present generation can fail to be interested in the career of the late Frederick E. Sickels, and reminiscences of his personal and professional experiences cannot fail to contain valuable lessons for everyone connected with the marine steam engine. The articles in your issues of April 4th and 11th show how deeply this man impressed his mark upon the engineering world. If I can contribute to the perpetuation of his well-merited renown, nothing can give me greater pleasure.

The writer was one of the junior engineers attached to the U. S. steamship "Pensacola," during the first two years of the War of the Rebellion; and coming in personal contact with Mr. Sickels every day, for some months, while that vessel was being fitted with machinery of his design, has stored in his memory many things in this connection which will be likely to interest engineers of the present day.

The machinery of the "Pensacola," or the bulk of it, was placed in the ship at the wharf in the Washington Navy Yard. It became reported late in the autumn of 1861, that the authorities felt it unwise or unsafe—owing to the well-known rebel proclivities of many prominent residents of Washington—to keep the ship at this wharf until the machinery was entirely complete; and for greater security she was towed to, and anchored off, Alexandria, Va., there to remain until such time as she could be made ready to sail. There were also suspicions afloat—in view of the many delays in completing the machinery—that possibly Mr. Sickels himself was influenced by sympathy with the rebellion, to purposely delay its completion. None of us engineers of the ship, however, believed there could be the slightest foundation for such a suspicion; nevertheless Mr. Sickels was confined to the ship by order of the Government, until everything was completed; and in this way we had unusual opportunity to observe his character as a man and engineer.

Whatever may be said as to his merits as an engineer and inventor, upon one thing we were unanimous; his native goodness of heart was beyond question; and I believe that his comparative ill success in life, pecuniarily, was principally due to his absolute lack of guile. He was gentle as a child, and was one of those men who would always go out of his way to avoid treading upon an insect.

Time often goes heavily on shipboard even with a man with such an active brain as had Mr. Sickels, but no one on the "Pensacola" at that time entered into the games and amusements resorted to to kill time with greater zest than did he. It was our custom often to have a boxing match before breakfast, in order to get up an appetite, in which he would always participate, and take the smashing of his high hat down over his eyes by the younger men with the greatest good nature.

I have met him many times since the war, up to about two years ago in New York, and he has never failed to manifest in most unmistakable terms, when referring to the above-mentioned imprisonment, the affection which he conceived at that time, and continued through his life to hold, for the young engineers with whom he became associated on the "Pensacola," and it was characteristic of his nature that he never forgot one of them.

As to his merits as an engineer, there will doubtless be great diversity of opinion, but that he was a brilliant and prolific inventor no one will question. Probably his greatest defect as an engineer was that he was too much an inventor. He was scarcely ever satisfied to-day with what he conceived yesterday, and would be pretty sure to improve to-morrow on his work of to-day, and to this redundancy of the inventive faculty in him, was greatly due the many delays in finishing the machin ery of the "Pensacola,

which finally aroused the suspicions of the Government as to his loyalty.

Few engineers of the present day are acquainted with the peculiarities of the original machinery of the "Pensacola," as designed by him, or in how many respects it represented what were for that time advanced ideas. As a whole, there was scarcely ever a greater failure than the steam machinery of that vessel. Yet there were incorporated in it engineering conceptions, of which many have since taken a prominent and permanent place in the best modern practice.

Probably one of the very first attempts to use forced draught by means of air-tight fire rooms, and blowers, was here made by Mr. Sickels, and it failed at that time only because of the inadequate provision made for procuring the necessary air pressure.

It is to be said, however, in extenuation of Mr. Sickels' designs, that the exigencies of the war decided the abandonment of more than one of his principal plans, where, under more deliberate conditions, they might, and probably would, have been brought to successful fruition. Not the least of these was the steam-steering apparatus, which, as indicated in your issue of April 4th, was representative of the type of this class of machinery now so universally in use on large steam vessels. The Figs. 5 and 6 on page 263 of that issue might well be taken to illustrate that machine just as it was placed on the "Pensacola," the principal differences being that on that ship the connections were of the "trunk" variety, and the valves were the ordinary D-slides None of us on that ship could ever see any good reason for its abandonment (at least no fault in it not amenable to correction), except that the exigencies of the pending cruise rendered everything in the way of experiments inadvisable.

The salient idea of Mr. Sickels in connection with this machinery as a whole, was the introduction of higher grades of expansion than had previously been used on any vessel of war, particularly in screw-propeller engines, and the procurement of this by means of his adjustable drop cut-off. I very well remember that his ideas ran in this way, involving a principle included in his cut-off patent which no writer on the subject, so far, seems to have noticed, viz., by using high grades of expansion to economize fuel in long runs under moderate speeds, and to gain high speed at a greater cost in coal per unit of power, by following the piston to any desired point with initial steam, which conditions he thought most desirable in a man-of-war. Previous to that time no considerable attempts had been made beyond the slide valve and link motion to procure variable expansion in direct-acting propeller engines, and his attempt to adapt his quick-closing drop cut-off to such a machine was a bold step for that day. The use of puppet valves, however, which was then inseparable from his ideas of a drop cut-off, was one of the principal factors in his final failure with this ship; and if he could have dreamed of the possible use of such steam pressures as are now employed on steam vessels, his prolific brain would probably have substituted means better adapted, even to the pressures he proposed to use.

It seems to have been overlooked by recent writers on Mr. Sickels' career, that one of the principal claims he made for his drop cut-off was that of moving the tripping mechanism coincidently with the piston, by means of which he was enabled to adjustably cut off the steam at any point beyond as well as before half stroke; in other words, to obtain any grade of expansion from the maximum on shortest cut-off to following full stroke. I remember with what persistence Mr. Sickels dwelt upon this; upon his being able to trip the valves "by a motion coincident with the piston," and that this feature constituted the most valuable part of his patent. Without this it is plain that his idea of providing engines for a war vessel in which the steam might be adjustably cut off at anywhere from $\frac{1}{10}$ to $\frac{8}{10}$ of the stroke, as was designed to do with this machine, was altogether out of the question; so that this feature of his invention was indispensable to the carrying out of his idea of adjustably using economical high grades of expansion for long, slow steaming, admitting the steam to follow further for greater power and speeds as exigency might demand for short periods; and to control such a range entirely by a variation in the grade of expansion.

In the light of to-day we can very well see how abortive must have been any attempt to procure any considerable degree of economy over what had previously been accomplished with propeller engines, while cutting off so short as one-tenth of the stroke under a boiler pressure of not more than 35 pounds, alike in four cylinders of 58 inches diameter and 4 feet stroke, and particularly when provided with such imperfect vacuum-producing appurtenances as had the "Pensacola," in which it was rarely ever possible to maintain more than 20 to 25 inches by the vacuum gauge.

There were, however, many devices incorporated in the machinery of that ship which contributed to its ultimate failure, and which went far to show that Mr. Sickels, like many other brilliant men of his kind, undertook to introduce too many innovations at once, many of which contributed to the defeat of all the others.

Notably among these was the condensing apparatus and air pump provision. Not satisfied to perfect and adapt a highly-expensive engine with adjustable cut-off to a man-of-war and to adopt therewith well-known and efficient means of producing a vacuum—a most vital consideration in such a machine under a maximum boiler pressure of 35 pounds—he contrived a surface condenser whose water circulation was to be procured by means of the ship's progress through the water. To make this matter more abortive he failed to provide anything like sufficient means for forced circulation when the ship was not in motion or had little progress through the water. Then to complicate the matter still further he failed to provide proper means for exhausting the air from the condensers by means of pumps driven by the main engines, and relied too greatly upon a pair of auxiliary air pumps, which he unfortunately arranged so as to be driven from the shafts of the blowers which were to supply air to the fire rooms in such a way that both objects were defeated.

In the general design of the main engines he introduced no end of novel and far-reaching departures from the practice of the day, which, while most of them did not prove to be at all in the direction of the subsequent development of the propeller engine, showed the trend of his mind and the boldness with which he was always ready to leave the beaten track.

The engines had four cylinders of the dimensions given above, placed horizontally athwartship in pairs with the piston rod heads facing each other in a pair. They were connected to the cranks direct by means of an ordinary straight connecting rod on one side, and on the other by an immense forked connecting rod, the fork of which embraced the entire crank of the opposite cylinder. There were thus three crank pins to each pair of cylinders. The cranks of each opposing pair of cylinders were placed opposite each other; so that the pistons of each pair of cylinders moved concurrently inboard and outboard. In this way the pistons in each pair reacted upon one another and relieved the main frame bearings from all working stress; these bearings had, therefore, nothing more to sustain than the weight of the shaft, and were only about one-third the length of the single crank pins and considerably shorter than one of the double crank pins. The cranks of one pair were at 90 degrees from the other.

If the reader will picture to himself such a machine with eight cam lifted puppet exhaust valves, and a corresponding number of puppet steam valves with their concomitant drop cut-offs and valve-tripping mechanism, expected to make from 60 to 75 revolutions per minute; with many other abnormal, not to say abortive adjuncts, such as referred to above, he will readily conceive that the engineers of that vessel had no sinecure on such a cruise as included the passage of the forts below New Orleans, and will not wonder that after that event the ship was anchored as guard ship off that city for about two years.

All this, however, does little to detract from Mr. Sickels' legitimate fame, for the reason that very much of what contributed to the failure of the ship, or rather her engines, was due to the fact that the urgent demand for the ship to take part in the war precluded him from the ultimate application of his genius to the perfection of his plans, or the correction of errors such as might have been expected in a departure whose total involved so marked an advance over precedent practice.

I recall many of the minor difficulties encountered by Mr. Sickels in the details of the machinery, and how prolific and prompt he invariably was to provide remedies for them. It got to be proverbial among the engineers of the ship when he encountered some obstacle, to say that Mr. Sickels would soon be found sitting alone in a certain place on the forward deck thinking out his remedy, as indeed was sure to be the case, and always with a happy result. There was but one occurrence of this kind which I remember that ever stumped Sickels, and that was probably not originally his fault so much as that of the draftsman, who laid out and proportioned the apparatus, and not discovered by Mr. Sickels until too late. As noted above, the fire room was to be supplied with air under pressure, by two fan blowers of very large diameter (some 12 feet, as I remember) made thus in order to run at so few revolutions per minute as would admit of driving the auxiliary air pumps direct from cranks on one end of the blower shafts. These air pumps were attached to one side of the blower case, and the engine driving them to the other, and similarly directly connected to a crank on the other end of the blower shaft. The sides of the blower cases were unfortunately so illy proportioned that the efforts of the engine, acting upon a crank opposite to that to which the air pump was connected, caused them to spring to an amazing degree, so much so as to render necessary the abandonment either of the blower fans, so that the sides of the cases might be braced or tied together, or the discontinuance of the use of the auxiliary air pumps. The former, being the lesser evil, was finally adopted. On the occasion of starting up this apparatus, and the discovery of the defect pointed out, Mr. Sickels and myself stood watching the disagreeable spectacle, when he remarked: "Hawkins, I would like to put a brace or two across there" (meaning inside, between the sides of the blower case), "but that is one of the places where the Almighty says you shan't put a brace."

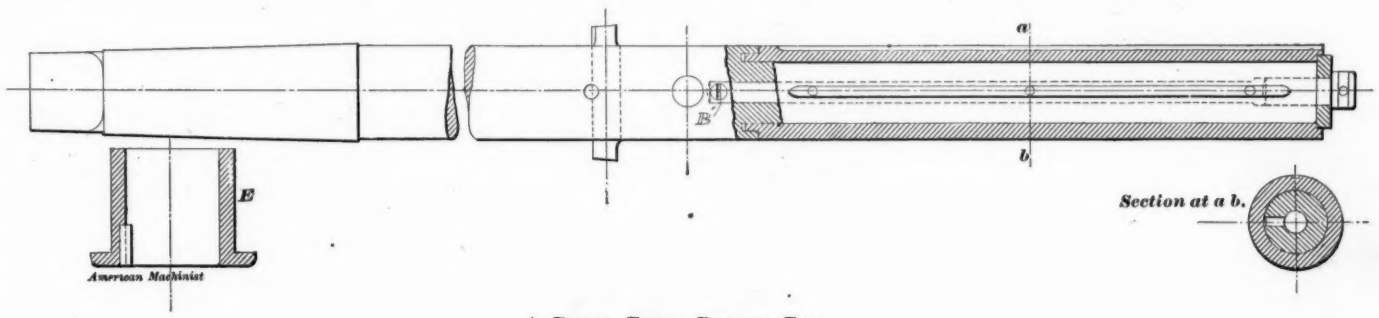
I have often felt, since the experiences related above, that it was a great pity that Mr. Sickels could not have been allowed to complete the machinery of that ship in his own way (for it was finally taken out of his hands, and made only as available as the circumstances would admit, in order to get her into active service in the war). If such had been the case, I am sure the engineering world would have had many more reasons to-day—and it now has many—to write the name of Frederick Elsworth Sickels on its roll of fame and honor.

Taunton, Mass. JOHN T. HAWKINS.

A Good Boring Bar for the Drill Press.

Machinists who have had experience in the use of boring bars in the drill press, know that where they are supported by a bushing placed in the table or in a fixture below the work, as is often necessary in order to adequately support the bar, chips, sand and fine iron dust falling from the cutter, get into this bushing and make more or less trouble. The bar shown by the accompanying engraving will therefore be interesting, because it obviates this difficulty, and by reducing the wear of bar and bushing is really a more economical tool, as well as more satisfactory, where much of such boring is to be done, as is the case in the shops of the Lodge & Davis Machine Tool Co., where the bar was made, and was recently found in use.

As will be seen by the engraving, the bar is fitted to the spindle in the usual way, and may be provided with a cutter of any desired form. Below the cutter is fitted a sleeve which turns freely on the bar, and is splined outside to engage a key which is fitted to the bushing *E*, which bushing is fitted to the hole in the drill-press table.



A DRILL PRESS BORING BAR.

A hole is drilled in the center of the bar, large enough to form an oil reservoir, and from this there radiate a number of holes to conduct the oil where it is needed. The reservoir can be filled by removing the screw at *B*. It will be noticed that the arrangement at the top of the sleeve is such that dust cannot well enter between the sleeve and bar.

Graphical Method of Finding Square Roots, Squares and Reciprocals.

BY R. E. HORTON.

The problem occurred recently of laying out on the drawing board a series of lines whose lengths should be inversely as the squares of the lengths of other given lines. Not having a table of squares and reciprocals at hand, and not caring to work out the results with great accuracy, I devised the following graphical methods for finding the square root, square or reciprocal of a line or number. Although perhaps not new, these methods were original to me, and proved so convenient that I think others may find them useful.

First, to construct a line whose length shall equal the square root of a given number. Referring to Fig. 1, lay off on any desired scale a line $A\ B$, whose length is one unit more than N, the given number ($A\ B = 1 + N$). At unit's distance from B, erect a perpendicular $C\ D$. With $A\ B$ as a diameter, draw a semicircle $A\ D\ B$. Then $C\ D$ is equal to the square root of $A\ C$. For from geometry a perpendicular from the circumference of a circle to a diameter is a mean proportional between the segments into which it divides the diameter. Hence, $N : C\ D :: C\ D : 1$, and $C\ D = \sqrt{N}$. The square roots of whole numbers are given in

tables, and may of course most conveniently be found from them, but by the above process the square root of any small number, whole or fractional, may be very readily found with sufficient accuracy for most plotting, and besides when so used it is already laid out on the drawing board.

Second, to find a line whose length shall be the square of a given number or line. This is the converse of the first problem, and the construction is as in Fig. 2. Draw a line $A\,B$ whose length on the scale chosen equals the given number or line. Through B draw $C\,D$ perpendicular to $A\,B$. From B lay off $B\,C = 1$. Join C and A and bisect $A\,C$ by a perpendicular cutting $C\,D$ at E. With E as a center, draw a semicircle through C and A, cutting $C\,D$ at D. Then $B\,D$ equals the square of $A\,B$. For $B\,D : A\,B :: A\,B : C\,B$. Hence, $B\,D : N :: N : 1$, and therefore $B\,D = N = \overline{A\,B}^2$.

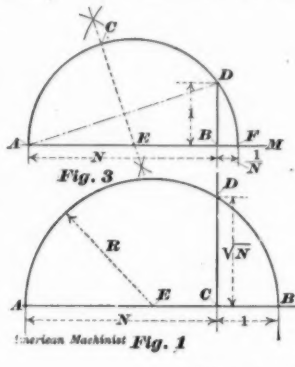


Fig. 1

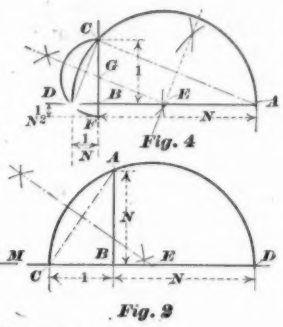


Fig. 4

Fig. 3

Fig. 2

GRAPHIC METHODS.

The third problem is to find the reciprocal of a line or number. As in Fig. 3, lay off on the given scale a line $A\,B$ whose length equals N, as before. Draw a perpendicular to $A\,B$ at B and lay off $B\,D = 1$. Join A and D and bisect $A\,D$ by a perpendicular $C\,E$, cutting $A\,B$ in E. With E as a center, draw the semicircle $A\,C\,D\,F$, cutting $A\,M$ at F. Then $B\,F$ is the reciprocal of $A\,B$. For $A\,B : B\,D :: B\,D : B\,F$, or $A\,B : 1 :: 1 : B\,F$ and $A\,B \times B\,F = 1$, or $B\,F = \frac{1}{A\,B}$.

These methods all depend on the principle of the mean proportional stated above, a proof of which may be found in any elementary geometry, but the practical accuracy which may be attained by their use depends on the scale adopted and the pains taken in making the construction. With a little care, the square root of a whole or fractional number may be found to two or three places of decimals, or at least as accurately as one can plot it, and in much less time than it would generally take to divide it out. Though whether to use this or the ordinary numerical method must be determined by the "case in hand and the man at the handle."

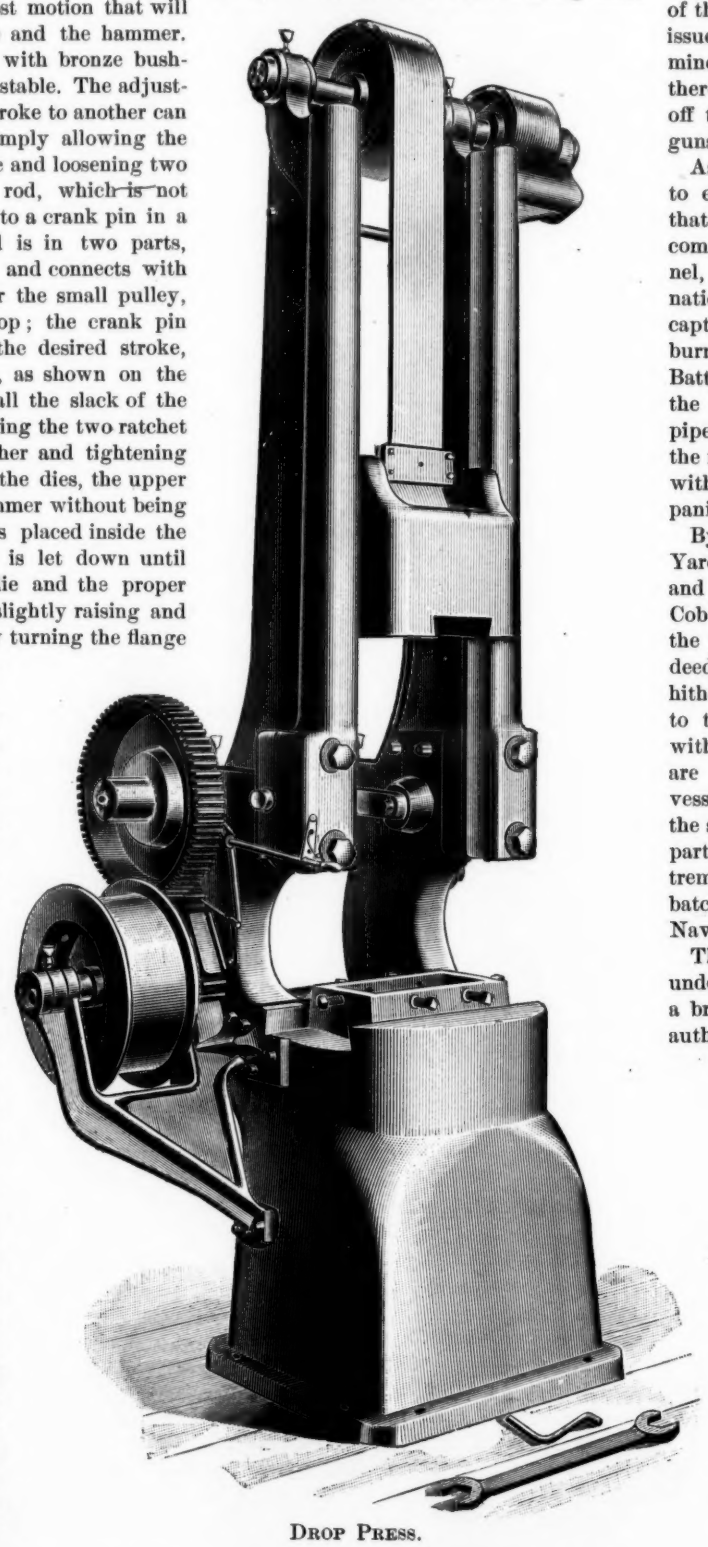
The original problem was to find a line whose length should be the inverse square of the length of another line. It was solved by combining the second and third problems given above. All the necessary construction is shown in Fig. 4. The reciprocal of $A\,B$ is found to be $B\,D$. Joining D and C and bisecting $D\,C$ by a perpendicular and using G as a center, we draw the arc $C\,D\,F$. Then $B\,F$ is the square of $B\,D$ and the inverse square of $A\,B$.

Automatic Drop Press.

The accompanying illustration represents a new automatic drop press. This machine is used for all kinds of sheet metal work, but is particularly adapted for silver work, such as spoons, forks and kindred articles, and the smaller sizes for the manufacture of jewelry, such as sleeve and cuff buttons and similar work. It is stated by the manufacturers that a boy with one of the smaller sizes of this press can turn out more and better work than it is possible for a first-class stamper to do with one of the ordinary plain drops, such as are commonly used. The machine is simple, easy to adjust and operate, and self-contained. The cut shows the driving mechanism of a 500-pound hammer; the driving pulley is 16¼ inches diameter by 6 inches face, running 180 revolutions per minute. On the same shaft is fastened a pinion 4 inches diameter; this pinion drives a stud gear 8 inches diameter with a pinion 4 inches diameter meshing into the crank shaft gear 18 inches diameter, hence running the machine 9 to 1. The crank shaft gear is connected to its shaft by means of a roller friction clutch, which is always ready to act the instant the small handle is raised, but with the handle in position, as shown, the clutch is disengaged and the driving pulley revolves freely on its shaft.

The cheeks for the support of the crank shaft are cast solid with the bed and are cut away to give plenty of free working space for the operator. The guides for the hammer are cast separate, and fastened to the front sides of the cheeks by bolts. They are tongued to grooves in the main castings, so that they will remain in line regardless of any vibration or strain to which the machine is subjected. The left-hand guide is provided with an adjusting screw at its lower end that enables the operator to always take up any wear or lost motion that will occur between the guide and the hammer. All bearings are fitted with bronze bushings. The stroke is adjustable. The adjusting from one length of stroke to another can be done very quickly, simply allowing the hammer to rest on the die and loosening two clamps on connecting rod, which is not shown, but is connected to a crank pin in a slotted crank. This rod is in two parts, joined by ratchet teeth, and connects with a belt, which passes over the small pulley, seen at the right, on top; the crank pin being then placed for the desired stroke, according to graduation, as shown on the crank arm, after which all the slack of the strap is taken up by placing the two ratchet halves of the rod together and tightening the clamps. To adjust the dies, the upper die is placed in the hammer without being fastened, the lower die is placed inside the die holder, the hammer is let down until it rests on top of the die and the proper adjustment is made by slightly raising and lowering the hammer by turning the flange pulley by hand to the right or left as desired, the proportion of the gearing being such that a man can easily lift the hammer in this way. After the dies have been properly placed, they are fastened and the machine is ready for work.

If the power is now started the hammer will rise to the hight for which it is set, the clutch is automatically thrown out, and the hammer remains suspended until the operator raises the small lever shown, which immediately re-engages the clutch with the crank shaft. When the hammer is up the crank arm is pointed downwards, and the crank pin center is practically directed under the center of the crank shaft; hence the weight of the hammer at this position has no particular tendency to turn the crank shaft in either direction, and to prevent it from accidentally turning a ratchet wheel engaging with a pawl, is fastened on the crank shaft between the two cheeks in such a way that it prevents said shaft from turning backwards, and when the hammer is at its highest position the tripping lever disengages the clutch mechanism, at the same time a lug or projection of the crank shaft brings up against the tripping lever and stops the crank shaft from being carried over the center by its momentum. The clutch mechanism is of peculiar construction and perfectly positive. It will take hold instantaneously when the operator moves the tripping lever, and also, as it frequently happens in this class of machinery, that when the hammer is descending it drops and causes the crank shaft to revolve faster than the motive power, the clutch being at this time engaged it is ready to act the instant the speed of the crank shaft is lessened. This is a very important feature, as when the hammer strikes it rebounds, and it is important that the clutch should be ready to act immediately after the rebound, so that the hammer will not be allowed to drop back. In some of the smaller sizes of these machines a safety stop is put on, so that should the hammer drop on account of the lifting strap or some of the mechanism giving out, this stop will prevent the hammer from dropping on the die, or possibly on the operator's hands; thus it will be seen that it is practically impossible for the operator to get injured by keeping his hands on the die and dropping the hammer. The die holder, as shown in cut, is not always used, for some work it being more desirable to use the ordinary style of poppets for holding the die. These machines are now being built in six sizes, with hammers weighing from 50 to 500 pounds, and a larger size to carry a 1,000-pound hammer is being designed. These machines are manufactured by the Mossberg Mfg. Co., Attleboro, Mass.



DROP PRESS.

Submarine Boats.

An engineer who has had more or less to do with, and has made some study of, naval matters, has given play to his imagination regarding the proposed new submarine boat, and he writes in the following, somewhat satirical, vein:

A contract for the construction of a submarine boat has at last been signed by the Government officials, the cost being nominally $150,000.

The new terror of the sea is expected to do the work that various military authorities fondly believed the "Vesuvius" capable of performing, to wit, sweeping the ocean of an enemy without danger to our own warriors; and divers blood-thirsty persons are girding up their loins afresh, and getting into training, for the pleasant and humane task of running under any future foe, with this latest acquisition, and discharging barrels of dynamite and bales of gun cotton, against his unprotected under-water plating.

Let us suppose that some foreign government, in an attempt to collect indemnity for outrages committed on citizens by one of our South or Central American States, has failed to show proper respect for our "Monroe doctrine," and that in consequence of the vigorous note of protest that has been issued by our State Department—has determined upon a naval demonstration, and has therefore sent a first-class iron-clad to cruise off the Liberty Statue, and train rapid-fire guns upon the unprotected Bowery.

Assume that the hostile ship has managed to elude the medical and customs sleuths that romp about at quarantine, and that she comes tearing through the Buttermilk Channel, her well-trained crew flushed with national pride—and "knock-out drops" captured on the Jersey coast—eager to sink, burn and destroy. She rounds to off the Battery, and taking a position from which the various approaches can be observed, pipes to dinner, while the band strikes up the national air, and a lieutenant goes ashore with the commander's ultimatum to the panic stricken city.

By this time word reaches the Navy Yard at Brooklyn, the alarm is sounded, and marines from the barracks and from the Cob Dock, rush to points of vantage about the yard, and, fixing bayonets, prepare for deeds of "derring do." Messengers run hither and thither, and the telegraph wires to the Department at Washington smoke with the burden of inquiries and orders that are suddenly driven through them. No vessel is found available for service except the submarine boat—and her engine is lying partly disconnected—and again the wires tremble, and the Central girls collapse in batches, as they struggle to transmit the Navy secret cipher.

The Attorney General at last decides that, under the pressure of such an emergency, a breach of law can be overlooked by the authorities, and that workmen can be engaged at once without passing the Civil Service examination as to their knowledge of ancient history, elliptic functions, and other useful branches of applied science, and at this decision the police are called upon, and mechanics are collared and dragged from their beds, hustled into patrol wagons, and bundled into the Navy Yard, and in a few hours a dock trial of the boat is under way, and valuable data of performance is being collected for future essays on engineering.

A draft of seamen has by this time been loaded into luxurious cattle cars at the Newport War College, and amid the cheers of the grangers along the route, comes bowling to the metropolis, and as the flashing of their cutlasses is seen upon the bridge the weeping citizens of the two cities feel that all is saved.

The last pound of coal is aboard, the final indicator diagram is taken and sent to the commandant under a heavy guard of seamen and marines of proved integrity, the crew of the submarine boat draw a last long

breath of free air, and, descending to the bowels of the monster, are securely battened down by skillful mechanics with long screw wrenches.

The lines are cast off, and, under guidance of the "Nina," the boat swings into the stream, and then, releasing the tug, steams towards the distant enemy.

The Battery comes in sight, and it is evident that the watchers in the military tops of the foreign battleship must not detect anything amiss, lest they advance their swift-moving torpedo launches and explode a case of dynamite too close to our protector for the comfort and safety of those in her.

The pumps are therefore worked until the conning tower is fully awash, and in this way the enemy's vessel is neared without exciting suspicion.

But it would be absolutely impossible for men groping in the dark, as those aboard our boat would be when under the crystal waves of such a stream as washes the shores of the cities of New York and Brooklyn, to strike a line through the swift and varied currents of the harbor waters, and after making several successful misses in locating the foe, a sight from the surface is necessary to regain bearings.

But, unfortunately, a bold, bad seaman of the enemy's ship is looking over the side, in dreamy fashion, wondering whether the proposed change of name in the main thoroughfare of the Empire City will be made, and spoil the fun of his next "liberty" in New York—an outing that all pious sailormen look forward to as one of the main objects in this life.

The slight break of surface caused by the sight drum of our defender catches his trained eye. He rouses from his reverie and springs the rattle, and in an instant the shriek of the boatswain's whistle calls all hands to quarters.

The Hotchkiss and Nordenfeldt guns in the tops open at once a perfect stream of projectiles that cut the water into a line of foam, and the spot at which our boat shows her turret is riddled by a thousand steel missiles.

Our men suddenly find themselves minus the steersman in the sight drum, the top of which is shot to pieces, and the water pouring in forces the full pump power to be exerted to keep afloat and forces a rise to the surface if the crew are not to be drowned like rats in a cage.

But the enemy is not idle and his launches rush forward and entangle our boat's propeller, and, making fast alongside, force our men to a humiliating surrender.

Such would be the least serious outcome of a battle between a submarine boat groping in the dark under the surface, and any enemy that had sufficient intelligence to man a modern ship, and in all probability those in the submarine craft would fare far worse than in the above description.

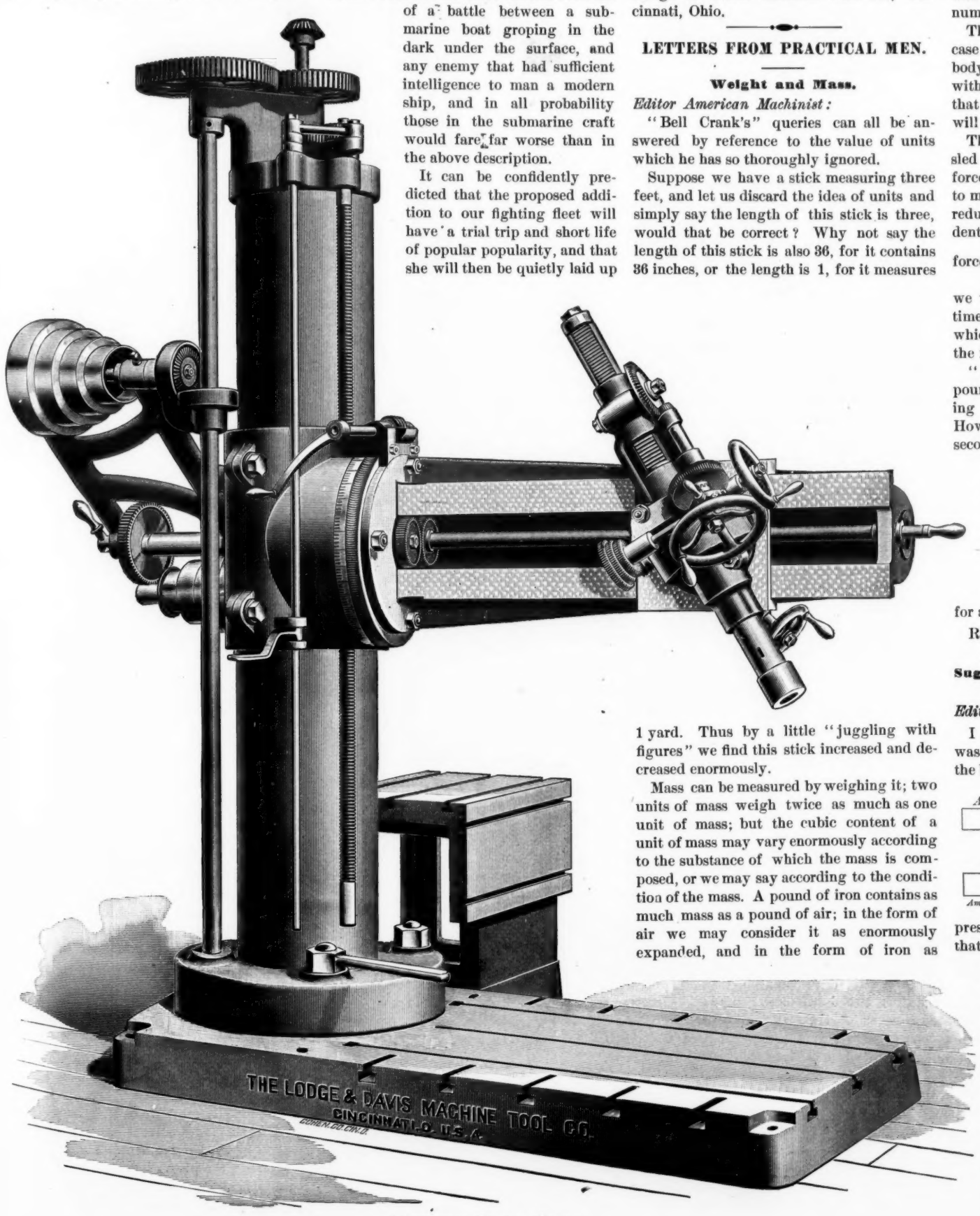
It can be confidently predicted that the proposed addition to our fighting fleet will have a trial trip and short life of popular popularity, and that she will then be quietly laid up "in ordinary" along with the "Vesuvius," the "captive balloons" and other revolutionizers of modern warfare that grace the out-of-the-way corners and back channels of various of our navy yards.

Universal Radial Drill.

We present on this page an illustration of a radial drill of the universal type, having a round column fitted over a cylindrical stump, which is attached to the bed plate, and is made long enough to support the column firmly, and allow it to turn easily.

Power is taken from the countershaft by bevel gears, one of the pair being of raw hide, and the arrangement is such that the arm can make a complete revolution.

The spindle is balanced by a coiled spring wound in the back of the rack wheel, and the feed is by a rack and pinion, with quick return motion. The different rates of feed are obtained by the well-known sliding-pin device, and can be changed while the machine is in motion. The arm is raised and lowered by power, and the head is moved by a helical gear and rack. The machine is adapted for tapping, and for this purpose a double-friction countershaft is provided. The machine is built by The Lodge & Davis Machine Tool Co., Cincinnati, Ohio.



UNIVERSAL RADIAL DRILL.

LETTERS FROM PRACTICAL MEN.

Weight and Mass.

Editor American Machinist:

"Bell Crank's" queries can all be answered by reference to the value of units which he has so thoroughly ignored.

Suppose we have a stick measuring three feet, and let us discard the idea of units and simply say the length of this stick is three, would that be correct? Why not say the length of this stick is also 36, for it contains 36 inches, or the length is 1, for it measures 1 yard. Thus by a little "juggling with figures" we find this stick increased and decreased enormously.

Mass can be measured by weighing it; two units of mass weigh twice as much as one unit of mass; but the cubic content of a unit of mass may vary enormously according to the substance of which the mass is composed, or we may say according to the condition of the mass. A pound of iron contains as much mass as a pound of air; in the form of air we may consider it as enormously expanded, and in the form of iron as in a greatly compressed or concentrated state.

Mass is a hypothetical quantity only measurable by its attraction to other masses and by its inertia; it cannot be measured by a two foot rule. By weight we understand the earth's attraction on bodies near its surface, but if we should extend the definition of weight to the attraction of other planets, then the weight of a body containing a certain amount of mass would vary considerably on different planets, and thus we see that weight and mass are entirely different quantities. Mass is invariably the same throughout the universe, but weight varies.

"Bell Crank" has a few problems which he wants us to solve.

"If a sled of one pound weight were placed on ice and assumed to move without friction, how much force in pounds will it require to move the sled one foot in one second? How much force will be required to move it two feet in one second?"

A mass that weighs one pound and is acted upon by a force of one pound will be accelerated as if falling under the direct action of gravity; the velocity will be gradually increasing and the increase will be equal for equal increments of time, and at the end of one second the velocity will be 32.2 feet per second, as has been proven by numerous experiments with the free fall.

The *mean* velocity will evidently in this case be half of the final velocity, and the body will therefore in the first second move with a mean velocity of 16.1 feet per second, that is, the displacement in the first second will be 16.1 feet.

This, then, would be the motion of the sled in one second if it was impelled by a force of one pound, but as we only want it to move one foot the mean velocity must be reduced in the same proportion which it evidently will be by reducing the impelling force to $\frac{1}{16.1}$ pound, or nearly one ounce. If we want to move it two feet in the same time the velocity of motion must be doubled which, of course, is obtained by doubling the force, making it two ounces.

"How much centrifugal force will one pound exert at the radius of one foot moving at a velocity of one foot per second? How much at a velocity of two feet per second?"

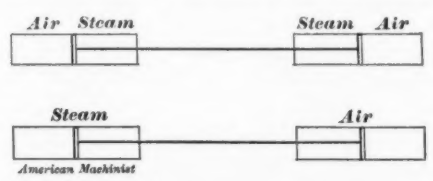
Centrifugal force = velocity^2 × mass ÷ radius. A foot being the unit of length we have mass = weight ÷ 32.2, and the centrifugal force will therefore in this case = $1^2 \times \frac{1}{32.2} \div 1 = \frac{1}{32.2}$ pound, or nearly half an ounce, and it will be one ounce for a velocity of two feet per second.

Ridgway, Pa. J. BEGTRUP.

Suggested Improvement in Air Compressors.

Editor American Machinist:

I once saw an air compressor, which, it was claimed, gave more equivalent power of the boiler pressure than usual. In this air compressor the cylinders were each divided so that one side of each took steam, and one side air, instead of one cylinder taking steam and one air. By this arrangement it was claimed that the steam followed up the piston into the superheated air space of cylinder, and absorbing the (about) 100 degrees of extra heat, generated by recent compression of air (over temperature of steam of same pressure) so superheated the steam and turned the slight condensation of steam into superheated steam also, as to enable the accumulation of air pressure in receiver to be maintained at some 110 pounds, with only 50 pounds of boiler pressure, while the absorption of heat



from the emptied air spaces of each cylinder so reduced the temperature of the air spaces of the cylinders, that no water jacket or injector was needed. At all events, it was a fact that with 50 pounds of steam and cylinders for steam and air of equal dimensions, and no compounding, the receiver showed about double the pressure that was on the boiler.

As newly compressed air always shows nearly double the heat of steam of equal pressure, and as heat always means power, and as this extra heat of the air is always, in use, wasted by cooling by water jackets around cylinder, or by injections of spray, or else lost by radiation in the air receiver, and as this waste represents a very high coefficiency of power owing to its excessive temperature, then it must follow, that until this wasted energy is by some device utilized, there must be a tremendous loss in transfer of steam power into air power. This waste, in old treatises, is declared to be equal to 70 per cent., and it appears to me that until overcome there can be only expensive conversion of steam power into air power. If you take into consideration the loss represented by 100 or more degrees of heat at a high range, friction, and condensation of steam in cylinders, it cannot but appear that air cannot be economically used as a motive power when generated or compressed by, and in competition with steam. The compressor mentioned seemed to be a step in the direction of utilizing the wasted forces, but how much of step, and how correctly explained in its operation, I am not prepared to assert, perhaps some of your readers can give information as to fact and theory. "NOTES."

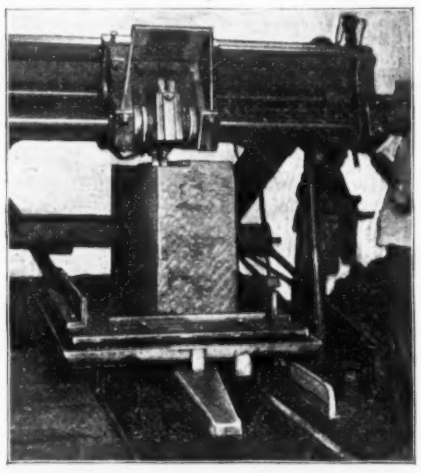
[The above communication may prove interesting and suggestive to our readers, but it is, however, necessary to say that it contains an astonishing collection of fallacies. It is well known that an air compressor with steam and air cylinders of equal dimensions will compress air to a pressure much higher than the steam pressure—often to about double the pressure. The air-brake pump will do this. No compressor can be devised, however, that will accomplish this result economically. In the best compressors of the day, 1¼ cubic feet of steam at 80 pounds will produce 1 cubic foot of air at 80 pounds, by using the steam expansively and condensing. In the arrangement spoken of by our correspondent, using steam in one end of a cylinder to compress air in the other end, when the end of the stroke was reached, the available volume of compressed air produced would be, after deducting something for clearance, and allowing for the inevitable cooling of the air before it was used, less than .15 of the original cylinderful, and on the other side of the piston the volume of steam in the cylinder would be more than .75 of the cylinderful so that the steam expended would be more than five times the volume of the air produced. With the air compressed higher, which would not be done by dead pressure, but by the momentum of the moving parts acquired in the earlier part of the stroke, the resulting volume of air would of course be less, the volume of steam consumed would be greater, and no better economy would be shown than before. The proposition to cool the air by superheating the steam is decidedly funny, when we know that even the water jacket is not a very efficient and satisfactory cooler. It is also amusing from the fact that the steam does not get at the hot end of the cylinder at all. The temperature of steam at 80 pounds gauge is 323 degrees, and the temperature of air, commencing at 60 degrees, does not reach 323 degrees until it is compressed to 45 pounds gauge, and to less than ⅛ of its original volume. After the compression had reached this point, there would still be the thickness of the piston to be traversed before any part of the cylinder surface that had been exposed to air as hot as the steam could be uncovered, or practically the steam could not touch any part of the cylinder to have any cooling effect. The steam would only heat the cylinder, and thereby heat the air at the beginning of the stroke, so that the cylinderful of air admitted would be increased in volume, or a less weight of air per stroke would be compressed and delivered. Other considerations equally fatal in practice might be suggested, but it would seem that we had offered enough.—ED.]

That Tipped-over Cross Rail.

Editor American Machinist:

As a constant reader of your esteemed paper for many years past, I take the liberty of saying a few words respecting the interesting articles recently published on "Machine Shop Milling Practice," by my respected friend, Horace L. Arnold. In the article of January 3, 1895, he speaks particularly of the form of cross rail adopted by the Ingersoll Milling Machine Co., and alludes to it as an "innovation" of very great value. With his statements regarding this matter I would in the main agree, but I shall be glad to have you correct it in one very important item, where he says that the tipping of the cross rail forward is an innovation. I built a machine in 1871, at Dukinfield, Cheshire, England, for milling stone, of which I send you a photo. This machine had a cross rail tipped forward at an angle of 45 degrees when the cutter head was at its lowest point or nearest the table. The block of stone shown in the machine being dressed is about 6 feet long, 3 feet 6 inches high, 22 inches thick, and the cut being taken is about one inch deep.

This milling machine I will endeavor to describe from scant data but vivid memory of 24 years ago. It was set on an ashlar



stone foundation 12 feet wide, 18 feet long and 4 feet deep, with an extension in front of 7 feet, and 6 feet wide, to carry front ends of the two V-table tracks shown in front lower part of photo. Crosswise on this foundation was bedded and bolted a cast foundation plate 3 inches wide, 12 feet long and about one foot 4 inches deep. This bed plate carried the lower ends of the two 3-inch diameter lifting screws and their swivel gudgeons, shaft, pulleys and boxes for driving same, as shown at right-hand side; also the table-drive gearing and pulleys on left-hand side of machine, but not shown in photo, the table reverse and tumbler shaft and weight seen in front of attendant's knee, and on its top edge in the center it carried the two V-tracks for table wheels about 20 feet long. After this foundation plate was set, the ashlar foundation was built up to the level of its top face for 20 feet long and 6 feet wide, to carry the projecting ends of the V-table tracks for table wheels. On the back end of the foundation, raised to somewhat above the track foundation level, there were two massive jaw trunnions, with 8-inch diameter hollow gudgeons pressed in them; the gudgeons received the two 8-inch bored pillow blocks that were cast on the back ends of radial or swinging frame; the right-hand trunnion is hidden from view by the block of stone on the table. Passing through these two hollow gudgeons and journaled in them was a small shaft about 2½ inches diameter, the right hand end shown carrying pulley with crossed and open belts to worm shaft of raising and lowering device, the principal feature of which was the 3-inch elevating screws under front of frame. This main framing that carried the cross rail from main swivels was composed of two box beams about 7 inches by 10 inches, with one inch metal cast about 6 feet 9 inches center to center. Crosswise to their front ends was cast a plate at an angle of 45 degrees, about 22 inches wide, 8 feet 10 inches long by 2 inches thick, well stiffened behind with two ribs 2 inches thick by 8 feet wide lengthwise of cross rail, and six ribs crosswise same size but ends rounded off to edges of plate. The back ends of these box beams had each an 8-inch pillow block cast to it 9 inches wide, bored to fit the 8-inch swivel gudgeons at the rear of the machine. The two 7 by 10 box beams or arms were further strengthened by a plate web on their upper front ends as far back from front plate as was admissible, but not to interfere with the passage of the block of stone being operated on when machine was dressing a block of the extreme hight or capacity of machine, and also had an I-beam cast between them just clear of the main swivels, as shown on back left-hand of picture, thus making a large open framework for table to travel under cross rail and between its arms about 13 feet long from center of swivel to center of cutter shaft. The front angular plate was planed on its face, and had the cross rail bolted to it with reamed bolts 6 inches pitch the whole length on both edges. This construction was not a matter of choice but necessity, as we could not find a planer in Manchester or neighborhood that could plane the Vs if cast on that size of a frame and at an angle of 45 degrees with its center line, hence the loose plate.

This plate cross rail was 2 inches thick all over with 2 inches additional to form Vs for cutter head stock to slide on. The cutter head stock was 22 inches square on its base or sliding surface and fitted with hard bronze boxes in a square jaw. The cutter shaft was cast steel 3 inches diameter with two ¾ inch by ⅜ inch deep grooves in it to receive two feather keys in cutter head and was carried by two bracket boxes, one at each end of cross rail as shown. This shaft we broke after a few weeks work, and it was replaced by a 3-inch square one after squaring out the cutter head. The chisels shown in the cutter head ran in an 18-inch diameter circle, and our table traverse was 2 inches to each revolution of cutter head. As you will see by the photograph, two chisels strike at the same time in each one-half revolution. The dressed surface was a series of waves 1 inch from crest to crest and 1 inch wide. When finished we used chisels 1⅛ wide, as shown in photo; when roughing off we used punches or points, a chisel about ¼ to ⅜ of an inch wide, but otherwise like those shown. Then the surface appeared to be grooved 1 inch pitch with a little raised roughness all along between the grooves, this roughness being taken off by the wider chisels and a finishing cut as stated above.

Now, as regards milling surfaces, we ran this cutter head at from 100 to 300 revolutions per minute, according to the hardness of stone, but always with the same table travel per revolution of cutter head. We have dressed a block on one surface 5 feet by 4 feet, or 20 square feet of surface in six minutes, one cut. It was a block for an engine bed 5 feet by 4 feet by 2 feet thick.

When working we used four small jets of water at a high pressure, one in line with each chisel, from an adjustable swinging nozzle supplied with rubber hose and faucet shown behind cutter head and under right-hand radial arm. These water jets were set so as to strike the stone at the same point as the chisels did, thus saving their points. The resulting mud from water and stone dust necessitated the use of the sheet-iron hood shown over the cutter head.

My U. S. patent (No. 138,100 issued in 1873) shows this feature of an inclined or tipped-over cross rail applied to planers.

Manistee, Mich. GEORGE R. RAY.

Inventor of the Corliss Valve.

Editor American Machinist:

I have been much interested in your biography of Frederick E. Sickels, also in Mr. Durfee's article, and in a sort of a roundabout way the following may possibly be of interest in this connection:

Some four years ago, in a conversation with Mr. William Wright, the engine builder, of Newburgh, N. Y., I mentioned that I had heard that he was the inventor of the rotating valves as used in the Corliss and hyphenated Corliss engines, and his reply was, as nearly as memory serves me: "Yes, that's so. In 1848 and 1849 I was foreman of a Corliss shop down on Fox Point, in Providence, and we had a large engine to build for ——, but while the rest of the work was well under way, the design for the cylinder was not yet determined, and Corliss used to ask me to come back to the shop after supper, and many nights we spent talking about that cylinder and suitable valve motions. One evening I showed him a sketch of a rotating valve, and described how it might be arranged with four valves substantially as in the present well-known forms, and Corliss made this reply: 'If I couldn't get up a better valve than that, I wouldn't try.' I told him that was the best I could do, and we went home. I kept the sketch, and have it now. In about three weeks, during which I heard no more about the cylinder, a set of drawings for the cylinder were made and sent into the shop, and they had my valve in them, and the cylinder was built that way." In reply to a question if he also invented the wrist plate, he said: "No. Corliss or his draftsman invented that."

I only mention this at this time in the desire to see justice done to all concerned.

C. S. BEACH.

To Prevent Iron Patterns Rusting.

Editor American Machinist:

I would recommend the M. P. P. Co., St. Louis (Question 147, April 11th), and any others having similar trouble (and this probably includes about every foundry using iron patterns), to try painting with red lead and linseed oil.

It is by far the best of anything I have ever tried. Linseed oil alone is much more effective than beeswax, which is but an imperfect protection.

Use boiled oil, and if the pattern is wanted for immediate use, put into the core oven for a short time—not long enough to burn the oil; no rusting is necessary.

Red lead mixed to a stiff putty with linseed oil is also an excellent thing for patching patterns, either wood or iron, adheres firmly, and is easily applied; by rubbing over the surface with black lead can be used at once.

It is necessary that the lead and oil should both be pure to get good results.

New Haven, Conn. E. TROWBRIDGE.

Forcing in Crank Pins.

Editor American Machinist:

As Mr. Bollinckx wishes to "render unto Cæsar the things which are Cæsar's," it would be very interesting to have Professor Sweet tell in the columns of your paper how long he has been making the "Straight line" fly wheels, by forcing both crank pin and shafts into the wheels, without any other fastening whatever.

Longdale, Va. J. E. JOHNSON, JR.

[And then it would be also interesting, perhaps, to note that the crank pins of locomotives have been pressed in and fastened in no other way for a long time—probably since long before the Straight line engine was invented, and locomotive crank pins probably have more need to be securely fastened in place than any other crank pins whatever.—ED.]

Suspected Steel Castings Accepted.

Four steel castings, made for the Government, by the Atha & Illingsworth Co., of Newark, N. J., and which were rejected last fall, on account of suspected irregularities in their manufacture, have now been accepted by the Government. The pieces in question are the piston heads, forming part of the machinery used to raise and lower the guns in the turrets. Owing to the trouble with Carnegie armor experienced

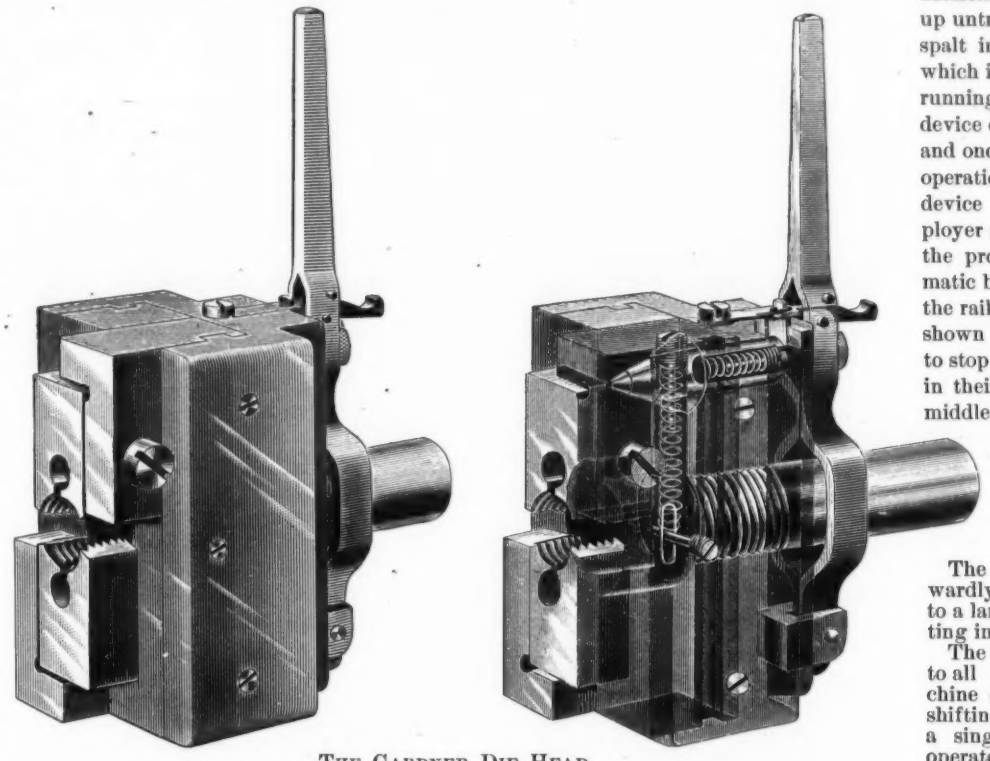
last year, these castings were carefully examined when delivered, and were found to contain blow holes, plugged and rusted over. The Government at once instituted proceedings against the firm, and the castings were returned. The company then asked for permission to machine the pieces, declaring that when reduced to proper size the metal would be found sound. This the Government would not allow. Recently, when the pieces were turned down, the metal was found to be perfectly good and sound, as asserted by the company.—*R. R. Gazette.*

The Gardner Die Head.

We present herewith engravings of a die head adapted to screw machine and other purposes, made to open automatically at any desired point, and yet so arranged as to hold the dies very firmly when cutting. The special feature by which this solidity is secured consists in placing each die upon a sliding block, which reaches over and has a bearing the full length of the head, the two blocks being placed side by side in the head, as indicated.

The dies are closed by a taper pin, which is forced into the slides by the lever shown, and when this lever is forced back by a suitably arranged tappet, the dies open quickly by the action of a helical spring.

There are comparatively few working parts in the head, and the long bearings of the sliding blocks make them wear well. It is found that the die will cut threads true to size, will do fine, close work, and will not clog with chips. They are made in four regular sizes to cut screws from the smallest to 1¼ inches diameter, by Chas. H. Besly & Co., 10 and 12 N. Canal street, Chicago, Ill.



THE GARDNER DIE HEAD.

Double-Block Power-Feed Shingle Machine.

The accompanying half-tone views show the front, Fig. 1, and rear, Fig. 2, of an improved double-block power-feed shingle machine. Its general design and construction is clearly shown by the cuts. Practically the weight is concentrated into four pieces—the two sides and the two ends; the sides are planed true top and bottom, and inner faces for bearings for the end and center-cross girts, the lead for the saw being planed in the top of the side piece; to this face a thin piece of iron planed true on top and bottom is fastened, which forms the bottom of the carriage slide way; when it becomes worn from constant use this strip can readily be removed, and be replaned along with the top adjustable gib, the two constituting the entire slide way.

In previous devices the lead for the saw is planed in the side or large pieces attached thereto, and when wear occurs the entire machine or the top of same has to be sent to the machine shop. The center post on back side of machine frame is made removable to allow the placing of an endless belt on the arbor pulley. It is machine fitted top and bottom, and when bolted in place is practically the same as a solid casting, the end cross girt serves for support for tilt table and crank shaft. Four guards cover up and protect the moving crank arm and connecting rod. The sawdust spout at the front has two hinge sections, when they are opened the saw can be readily removed from the machine; the right-hand section is made adjustable for the purpose of following up the wear of the saw; the left-hand section terminates in a curve that directs the sawdust to the rear of the machine, from whence it can be conducted to any convenient place by suitable conveyors. The interiors of the several spouts are smooth, and offer no obstruction to the sawdust. The adjustments of every shingle machine are practically limited to the manipulation of the tilt table, the arbor and other boxes on the machine, while the safety of its operation is largely contingent upon the control which the operator has of his carriage movements.

Either carriage may be stopped independently of the other (the one continuing cutting) by the respective foot trips shown in cut at the right and left-hand end of the machine; the purpose gained thereby is, first and most essential, the removing of the spalt when the carriage stands still, the carriage only stopping off from the saw with the dog wide open, and the spalt or block therefore lying free upon the tilt table. No person unaccustomed to operating the power-feed machine can, with safety to himself, or with profit to his employer, step up untrained to a machine and pick out the spalt in the space of one-ninth of a second, which is the limit of time with the machine running at 60 clips a minute, but with this device one entire stroke is ordinarily missed, and one second of time allowed in which the operation may be performed. This safety device is as much a protection to the employer as the safety rope on an elevator to the proprietor of a building, or the automatic brake and signal device on a train to the railroad companies. The center foot trip shown in cut enables the operator instantly to stop both carriages at once at any point in their movement by simply depressing the middle foot trip, leaving, as with the independent stop motions, the sawyer's hands entirely at liberty. A latch shown may be thrown down to engage the foot trip and prevent carriage from moving.

The interlocking fingers projecting inwardly from each of the carriages prevent, to a large extent, shingle bolts or spalt getting in between the two carriages.

The six independent adjustments common to all tilt tables are in this particular machine each accomplished and completed by shifting a single independent acting screw; a single lever at each end of machine, operated by the sawyer's foot or hand, grains the shingle by stopping the tilt from shifting, allowing as many butts or points to be made either one way or the other, as desired; the saw is ranged in any direction by shifting two screws; the lead of saw is altered without tightening or disturbing the cap on the arbor, or its seat on its supporting step, and the arbor cap is adjusted without varying the lead of the saw.

The arbor and arbor heads are one piece of steel.

A carriage driven from one side has a tendency to cramp and bind in its guideways. At least 90 per cent. of this is overcome when it is driven from the tight side, or the side that receives the saw thrust in cutting. By driving it from both sides, as in this machine, the 10 per cent. of friction is overcome.

The four crank arms are suitably connected at their upper ends to the carriage and pivotally fastened at their lower ends to the machine frame, the holes in same are bushed and when worn can be readily tightened by substituting a new pin and bushing; the sliding crank arm boxes are made in two parts dovetailed together at an angle to their friction faces, so that by shifting one upon the other, by a suitable bolt provided therefor, the sliding faces are expanded and take up all wear, keeping the boxes tightened and preventing any jarring; suitable oil cups serve to secure proper lubrication.

Quite a departure in several particulars has been made in designing the carriage. First, the spiral brass dog springs have been abandoned, and a clock spring of 1¼x¼-inch steel substituted.

Second, the wide side bar preventing the sawyer getting close to his work, and forcing him to handle his bolt in an awkward manner, is dispensed with, and a square bar used which retains the strength and affords more end friction surface to the carriage.

This machine is made by Perkins & Co., Grand Rapids, Mich.

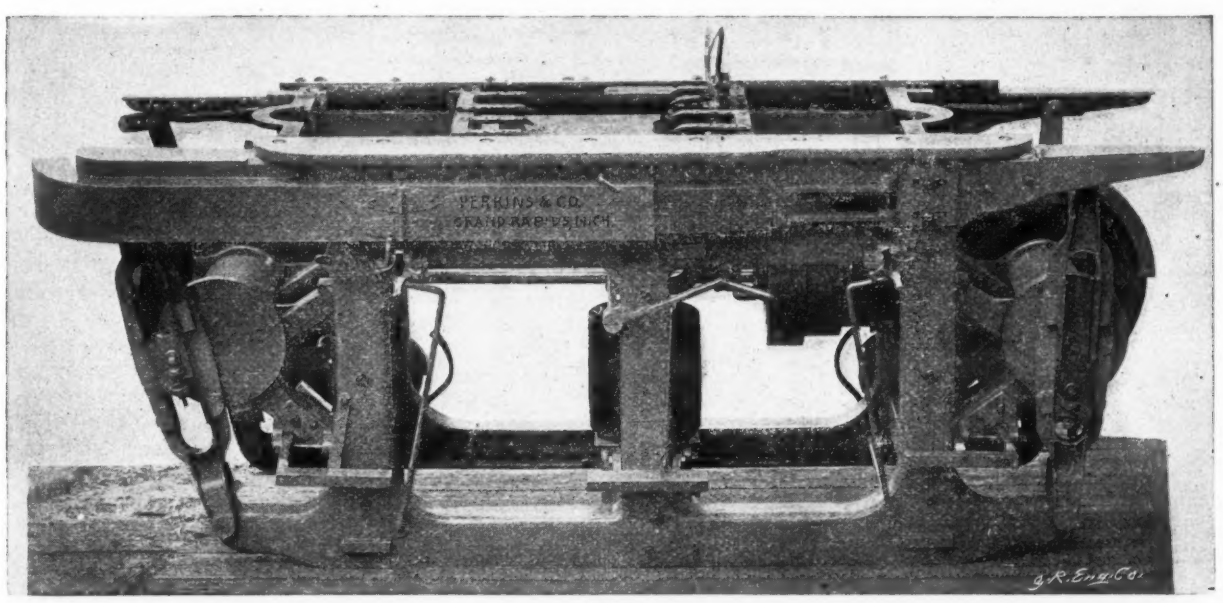
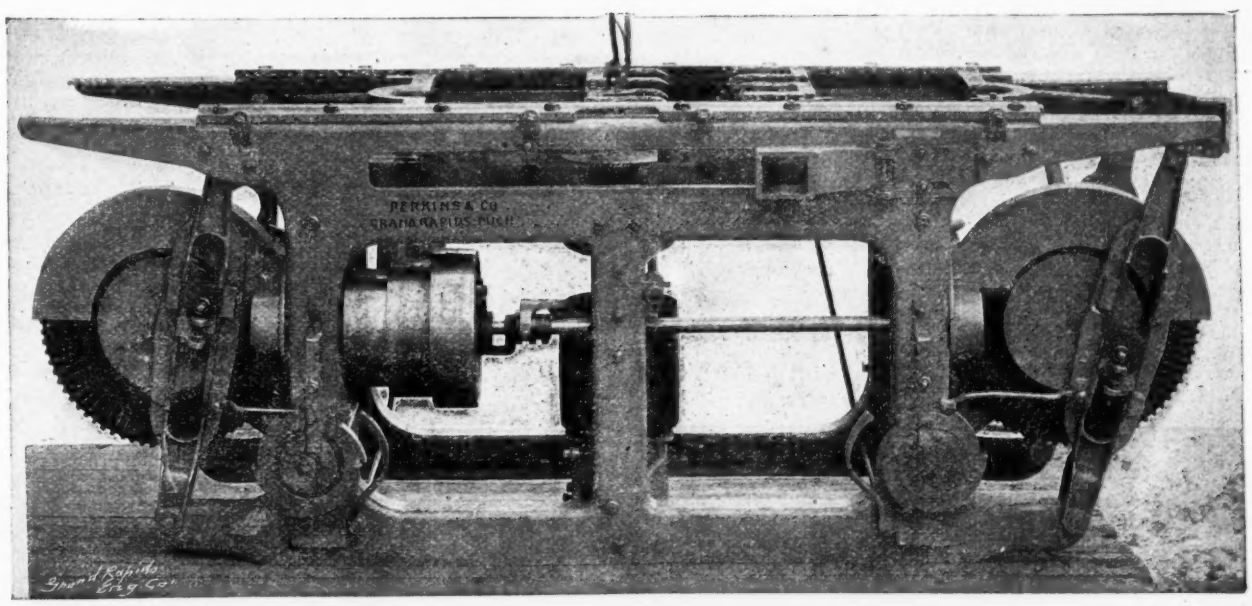


Fig. 1.



DOUBLE-BLOCK POWER-FEED SHINGLE MACHINE.—FIG. 2.

AMERICAN MACHINIST

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NEW YORK, MAY 16, 1895.

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A Benighted Manufacturer.

A little pamphlet issued by the Meriden Machine Tool Company, contains what is called a "true story" that ought to be very instructive to a certain class of men. According to this story, a manufacturer was making a certain piece of work by the old time-honored methods, keeping a machine and a man busily employed at a cost in wages of about $750 per year, besides shop expenses. He was shown that by the purchase of a new machine specially adapted to the work at a cost of $165, the wages cost for an equal amount of better work would be reduced to $78, but he said he "couldn't afford to pay $165 for a machine and have it standing idle five days out of every six."

If such a man can remain in the manufacturing business very long, making goods which come into competition with those of other manufacturers, it certainly indicates that there is a great deal of missionary work yet to be done by machinists; for it shows, not only that this man is still untouched by the spirit of modern progress and knows nothing of what the nineteenth century tool builder is doing for mankind, but that there are many others who, like him, are still in outer darkness, and must sooner or later become enlightened, take advantage of the machinist's art, or go out of business to make room for others more in touch with the spirit of the age in which they live.

Instead of the incident being discouraging to the machinist it should be the opposite, for it indicates to some extent the vast field in which there is much yet to be done—in other words, much machinery to be put in.

Use Others' Knowledge of Your Business.

Several letters lie before us that are fair samples of such letters as we are receiving continually, and that go very far toward compensating us for other and less pleasant features connected with the business.

One of these letters is from a tool maker, who writes upon the letter head of a large manufacturing concern in the West. He says:

"I desire to express my thanks to you. Your paper has been half of my success in the business. It has helped to place me in a position of responsibility, and at one time (when I was in business for myself) saved me several hundred dollars."

Another letter is from the superintendent of one of the largest engine-building establishments in the country. His check for renewal of subscription miscarried, and he writes: "Please see if this has not yet been received, but do not stop the paper, for what would my life be without the 'MACHINIST'?"

Other letters are from apprentices, students and professors in technical schools, journeymen machinists, and others, here and abroad, all acknowledging the great benefits received through reading what their fellow mechanics have written for publication in this paper.

But, "there are others," and amongst them are those mechanics who, though ambitious and fairly intelligent naturally, seem to have the mistaken idea that their own personal experience is sufficient to cover all the knowledge of their business they will ever have use for. Such men seem rather to despise the literature of their chosen profession, and to imagine that the reading of it is in itself a humiliating confession of ignorance.

If such persons could look through the contents of our mail box occasionally, and could know the kind of men who most freely express their indebtedness to others, and their appreciation of our efforts to provide a medium for exchange of thought and ideas amongst mechanics, some of them at least would probably conceive a new idea—would have a different conception of the character and dignity of their business, and might be able to realize what the greatest physicians, lawyers, and other professional men have always fully appreciated, *i. e.*, that no one man's personal experience can ever cover the entire field of knowledge pertaining to his business, and that no matter how much he may himself know, that part of others' knowledge which he can acquire will always be very useful and of very great value to him.

Locomotive Power to be Doubled.

A friend sends us a clipping from a newspaper in which it is announced that a Texas man has discovered that, as at present arranged, the locomotive is propelled by the forward stroke of the piston rod only, and that after a forward stroke has been made the piston rod then flies back, all the power of this back stroke being lost.

The Texas man does not stop at the mere discovery of this defect, however; he goes further and points out the way in which it can be remedied, and this is by the simple expedient of "what is technically called a bell crank lever," which he connects with "the driving rod and also with the forward driver."

We should imagine that the "scientist fellers" that have been putting indicators onto locomotive cylinders and taking cards from *both* ends of them, and then basing their calculations of horse-power, etc., on the assumption that the back stroke of the piston did rather more work than the forward stroke would feel pretty cheap when they come to know that just half the power shown by their cards has had no effect whatever in pulling trains. But when "The forward stroke of the piston rod sends the arm connected with the driving wheel up, the back stroke brings it down, and as it comes down it does its part in driving the wheel onward"—then the indicator cards taken from the front end will mean something besides a mere backache for the deluded fireman, and locomotive builders, now skeptical no doubt, will recognize that untrammelled genius discarding and despising all previously acquired knowledge has again made a ten strike.

The Railroads and the Hard Times.

The influence of the recent commercial depression upon railroads and the reactionary influence of railroads upon the commercial depression is shown by a writer in the May number of *The Peterson Magazine*, wherein it is stated that the New England roads, by the economies they practiced, succeeded in actually increasing their net earnings $2,200,000, notwithstanding a decrease in gross earnings of $2,500,000, and a list of eighteen prominent railroad systems is given, in which the total economies practiced amount to $53,063,523, though on most if not all of these roads the gross earnings fell off much more and there was a decrease of net earnings. We do not see how the showing of the New England roads can be considered at all creditable in this matter, and we doubt if the interests of stockholders or of anyone else, except possibly speculators, were conserved by such evidently unnecessarily rigid economies, which must have been carried out only by permitting a deterioration of track and rolling stock, which must, sooner or later, be made up at greater expense than would have been involved in avoiding it in the first place, or at least so much of it as could have been avoided by the expenditure of the two millions of dollars and over squeezed out of them.

In *The Forum* for May, Prof. R. H. Thurston has an article in which he makes a strong plea for the inventor and for the preservation of our patent system. In this article, our unprecedented development industrially and socially here in this country is attributed to our superior patent system and our free political institutions. This is quite orthodox and in large measure correct, of course, but we think the most important feature among the causes of our rapid development is overlooked, as indeed it generally is. To the circumstance that when government was fully and firmly established here and our vast territory was ready for settlement under the protection of established government and wise laws, the steam engine was also sufficiently developed in its various forms to take from men's shoulders the main part of the labor of development and bring distant parts of our territory into easy communication; in other words, that our country and the steam engine have developed simultaneously, is to be attributed, we think, our phenomenally rapid development.

Without the steam engine in its various forms, this country would certainly have developed at a much slower rate, and probably not much if any faster than other countries were developed. If a new and fertile continent were yet to be discovered and at the same time mankind were given a discovery by which the results of labor were to be increased tenfold or more, that continent, so long as access to its soil remained free or nearly so, would develop with unprecedented rapidity, and it is probable that good or bad patent systems would have surprisingly little influence in accelerating or retarding that development, though this is not saying that a good patent system is not desirable nor that the inventor should not be protected and encouraged, as we believe he should be.

In the erection of the tall office buildings wherewith lower New York City is being rebuilt, the steam derrick is the most important and all dominant agency. As a rule these derricks pick up a wagon load of material at a time and deposit it just where it is wanted. We lately passed one of these buildings where a lot of flooring stuff was being passed up by hand to the fourteenth story with a man at each story. Here 14 men were doing the work at less than one-fourteenth of the speed of the derrick, $14^2 = 196$.

Literary Notes.

ENGINEERING EDUCATION. Proceedings of the Second Annual Meeting of the Society for the Promotion of Engineering Education, held in Brooklyn, New York, August 20-22, 1894, in conjunction with the American Association for the Advancement of Science. Volume II. Edited by Geo. F. Swain, Ira O. Baker, J. B. Johnson, Committee.

This book contains the papers read at the Brooklyn Meeting of the Society for the Promotion of Engineering Education. These papers were presented by professors holding responsible positions in the work of engineering instruction, and point out the manner in which engineering education can be advanced; they also refer to the character of text-books desirable for teaching. All these papers are exceedingly interesting, and will be of great value to all concerned in the education given to students in our engineering schools. Even persons outside of the engineering profession will, we believe, find much pleasure in a perusal of the pages of this book. It also contains a list of officers and members, and the constitution of the society.

Copies of this volume and also Volume I. can be had by addressing J. B. Johnson, Secretary of the Society, Washington University, St. Louis. Price, $2.50 each, postpaid.

CONTRIBUTORY INFRINGEMENT OF PATENTS. By Hubert Howson, of the New York Bar.

This is a pamphlet containing a paper read before the American Association of Inventors and Manufacturers at Washington, D. C., January 15, 1895, and explains some points connected with patents, and with the use of patented devices which are not generally well understood.

NYSTROM'S MECHANICS. Twenty-first Edition. Revised by Robert Grimshaw.

This pocket-book of mechanics and engineering is so well known as to need little introduction. It is a valuable reference book, more adapted, however, to the needs of civil than those of mechanical engineers. Much new matter has been added in this edition, and in cases where recent determinations or authorities have given slightly altered values or constants, these are noted so that proper allowance can be made where extreme accuracy is desired. The original tables being, of course, sufficiently close for

most practical purposes. At the same time, obsolete or not sufficiently verified matter has been replaced by that which is likely to be more valuable. The book is published by the J. B. Lippincott Co., Philadelphia.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(200) H. C. W., Camden, N. J., writes: Please inform me of the composition of Parson's white brass used in bearings for large marine engines. *A.*—The composition of No. 2 quality is: tin, 68; zinc, 30.5; copper, 1, and lead, 0.5. It is used for facing and lining bearings.

(201) O. B., South Brooklyn, N. Y., writes: Please inform me what pressure in pounds I can obtain with a cam and roller as per inclosed sketch. *A.*—To answer your question we must know the amount of force applied, the manner of applying it, and the kind of metal of which the roll and cam are made.

(202) W. H. C., Philadelphia, Pa., writes: Please inform me how to prepare paper for blue printing. That is, I want to know what chemicals are used on the paper before the blue print is taken and how they are applied. If you have published this information in a previous issue please give the date. *A.*—See answer to Question 120 in our issue of March 8, 1894.

(203) J. G. G., So. Lake Linden, Mich., asks: What grade of leather is used in making the packing for a Corliss engine dash pots? *A.*—In many of these dash pots no leather packing is required. Should a leather packing be necessary, we should use oak-tanned sole leather of suitable thickness. 2. Which is the most economical for line shafting, grease or oil? *A.*—Oil; the grease will not flow until the bearings are heated to some extent, which is objectionable.

(204) E. N. V., ——, writes: If the bolts of a cylinder head be tightened until the total strain upon them is, say, 6,000 pounds, and steam be admitted into the cylinder, subjecting the head to a total strain of, say, 5,000 pounds, will the strain of the bolts be increased, and if so, to what extent? *A.*—This question has been fully discussed in our issues of August 6th and 20th, September 10th, October 1st and 27th, 1887, and July 2d, 1891. Probably in most cases, if not in all, there is no increased stress upon the bolts until the total pressure upon the head exceeds the total initial stress upon the bolts due to tightening the nuts.

(205) O. N., ——, writes: I want to condense steam at a temperature of 220° Fahr. by means of air at a temperature 60 degrees. How many cubic feet of air will it take to condense 1 cubic foot of steam, under the above conditions? Please give method of computation. *A.*—This problem can be solved in the following way: Weight of 1 cubic foot of steam at 220 degrees = .0435 pound. Total heat of steam above water at 212 degrees = 968. Heat units to be taken out of 1 cubic foot of steam = $968 \times .0435 \times 1 = 42.116$. Say that the air to condense the above may be heated from 60 to 180 degrees = 120 degrees. Weight of 1 cubic foot of air at 60 degrees = .0761. Specific heat of air = .2377. Then $120 \times .0761 \times .2377 = 2.17$ heat units to raise 1 cubic foot of air from 60 to 180 degrees; and $42.116 \div 2.17 = 19.4$, say 20 cubic feet of air required to condense 1 cubic foot of steam at 220 degrees to water at 212 degrees.

(206) C. L., Milwaukee, Wis., writes: Suppose we have two bodies of equal size, but different in weight, placed together in a cylinder or in a wide recessed rim of a fly wheel; now, suppose the fly wheel is started very slowly, and its speed gradually increased, which of these two bodies will reach first the outer periphery of the wheel? *A.*—If the fly wheel is placed in a horizontal position, and the bodies fixed so as to cause them to move in a radial line only, and both are placed at the same distance from the center of the fly wheel, they will reach the periphery in the same time. 2. If the weight of one of the bodies is one-quarter greater than that of the other, will the heavier body always exert a pressure one-quarter greater than that of the lighter one, or will the pressure of the heavier body increase at a greater rate than that of the lighter one as the speed of the wheel increases? *A.*—The ratio of difference in pressure of these two bodies against the outer periphery of the fly wheel will be the same at all speeds of the wheel.

(207) O. A., Fitchburg, Mass., writes: Please explain the formula $w = a - b \frac{l}{r}$, given in connection with a literary note on page 308 of your issue of April 18th. Also from whom can I get a drawing of the Hesse hydraulic footstep. Are there any books published treating on these subjects? *A.*—The formula referred to is used for finding the allowable pressure per square inch of wrought-iron Z-bar columns. In this formula, w = pressure in pounds per square inch, a = a constant, b a constant multiplier, l = length of column in feet, and r = radius of gyration. For columns with square ends, and for lengths over 90 radii, $a = 10{,}600$, and $b = 30$; substituting these values for the corresponding letters in the formula referred to, we have:

$$w = 10{,}600 - 30 \frac{l}{r}.$$

You will find this formula and the method of its application in the "Pocket Companion," issued by Carnegie, Phipps & Co., Pittsburgh, Pa. A pamphlet describing the Hesse footstep can be had by addressing Professor Hesse, University of California, Berkeley, Cal.

(208) M. W., Cleveland, Ohio, writes: I have a polar planimeter made by the American Steam Gauge Co. I wish to know how to correct it, as it makes no two readings out of a great many alike. I have made a triangle on a B. & S. universal miller, which, according to calculations, contains an area of one square inch, but after many trials I am unable to make two tracings to read the same area, the variations are from 89 to 100. I am accustomed to repairing and making scientific and mathematical instruments, but this is a strange thing to me. *A.*—It is hardly to be expected that all readings must be absolutely correct, or alike; however, the difference in your readings is too great. This difference may be caused by not handling the instrument correctly, or by some play in the joints of the instrument, or the difference may be due to both of these causes. It is impossible for anyone to state how to correct the inaccurate action of the instrument without examining it. We should advise you not to attempt to repair the instrument without understanding the principles of its action, and these you will find explained, and calculations given, in our issue of January 28, 1892.

(209) C. G. E., Baltimore, Md., writes: Kindly give me a recipe for making black lacquer for brass and steel. Also give the manner of applying these lacquers. Is there any white lacquer for brass and steel? *A.*—The process of lacquering or japanning, frequently adopted in machine shops, is to give the articles made of brass, steel, or iron, a coat of black Japan varnish made specially for the purpose, and then placing the articles in an oven and allowing them to dry in a temperature of 250 to 300° Fahr., or higher. By this process the articles will have a uniform glossy surface which is retained on cooling. Metals can also be given a lustrous black as follows: The bottom of a cylindrical pot, which should be about 18 inches in hight, is covered half an inch with powdered bituminous coal; a grate is then put in and the pot filled with the articles to be varnished. Articles of cast-iron, iron wire, brass, zinc, steel, etc., may be subjected to the same treatment. The cover is then put on and the pot heated over a coke fire under a well-drawing chimney. In the beginning the moisture only evaporates, but soon the coking commences and deep brown vapors escape, which irritate the throat. When the bottom of the pot has been heated for 15 minutes to a dull red heat the coal has been mostly converted into coke; the pot is then removed from the fire, and after standing for 10 minutes opened for evaporation, all the articles will then be covered with a thin lustrous coating which cannot be easily scratched. This lacquer is not only a protection against oxidation of metals, but will stand also a considerable heat, only disappearing at beginning of redness. White grounds are obtained with greater difficulty, and we do not know of a white lacquer which will give satisfactory results.

(210) A. R., Chicago, Ill., writes: Please illustrate by an example the solution of the following problem: A boiler evaporates the water under a gauge pressure of 70 pounds, from a feed water temperature of 60 degrees; this boiler is rated by the Centennial standard at 100 horse-power. Now, how can I determine the horse-power of the same boiler evaporating the water under a gauge pressure of 100 pounds from any given temperature of feed water? *A.*—The Centennial standard for a commercial horse-power is the evaporation of 30 pounds of water per hour from feed water at a temperature of 100° Fahr. into dry steam at 70 pounds gauge pressure per square inch. From the definition of this standard, it will be seen that in order to compute the horse-power of the boiler when steam is formed under a gauge pressure of 100 pounds, we must know the amount of water evaporated under these conditions. We may say, however, that, if the boiler is found to be one of 100 horse-power when steam is formed under a gauge pressure of 70 pounds, then, if the grate surface remains unchanged, and the same amount and quality of coal is burnt per hour, the horse-power of the boiler will practically remain the same when steam is formed under a gauge pressure of 100 pounds, for the simple reason that the evaporation of water will depend on the amount and quality of coal burnt in a given time, and if this amount is not changed, there will practically be no change in the amount of evaporation. This will probably be better understood by working out an example. Let it be required to compute by the Centennial standard the horse-power of a boiler which evaporates 3,000 pounds of water per hour under a gauge pressure of 100 pounds, the temperature of the feed water being 80° Fahr. The feed water, at a temperature of 80 degrees, contains 80 units of heat (this is not quite correct, but is sufficiently close for ordinary purposes). The number of heat units in a pound of steam under an absolute pressure of $100 + 15 = 115$ pounds is 1,217; subtracting the heat units of the feed water, we have $1{,}217 - 80 = 1{,}137$ heat units, which must be supplied for the evaporation of one pound of water into steam of the required pressure, and to evaporate 3,000 pounds of water per hour, we require $1{,}137 \times 3{,}000 = 3{,}411{,}000$ heat units, and these must be furnished by the coal. Before we can finish this computation and find horse-power of this boiler we must know the number of heat units demanded by the Centennial standard. The feed water, at a temperature of 100° Fahr., contains practically 100 heat units, and the number of heat units in a pound of steam under an absolute pressure of $70 + 15 = 85$ pounds is 1,210.2; subtracting the heat units of the feed water, we have $1{,}210.2 - 100 = 1{,}110.2$ heat units required for evaporating 1 pound of water under the given conditions, and for evaporating 30 pounds of water per hour we require, according to the Centennial standard, $1{,}110.2 \times 30 = 33{,}306$ heat units. Now, dividing the number of units required for evaporating the 3,000 pounds of water, as given in the example, by 33,306, we have

$$\frac{3{,}411{,}000}{33{,}306} = 102.4$$ horse-power for the boiler. The whole matter may be summed up as follows: Find the number of heat units required to evaporate the given quantity of water as explained above, and divide this number by 33,306, which is the number of heat units per horse-power as demanded by the Centennial standard.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 392.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 157 William St., N. Y.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Yacht engines and boilers. Great variety. New catalog free. Willard & Co., 197 Canal St., Chicago.

Air Hoist Circular. Whiting Foundry Equipment Co., Chicago, Ill.

American packing rings are in touch with the cylinder. New circular about rings and pistons. J. H. Dunbar, Youngstown, O.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

"Modern Locomotive Construction." By J. G. A. Meyer. In this book the design and construction of all details of the locomotive and tender are considered from a practical standpoint. It contains illustrations of details made from working drawings, accompanied by plain directions for designing, and rules and tables for construction. Adapted to office and shop use. Price, $10. Published by John Wiley & Sons, 53 East Tenth street, New York.

The Efficiency of Compound Locomotives.

The last monthly meeting of the local members of the A. S. M. E. for this season was held at the society's house Wednesday evening, the 8th inst., and the subject of "Compound Locomotives" was introduced by Mr. F. W. Dean, of Boston, who said in part:

The compounding of locomotives presents to the railroad companies of this country the greatest means of fuel economy that has been placed within their reach, and it is fair to assume that this is the greatest of all the economies that can be carried out by railroads. A type of engine that can clearly save fully one-quarter of the coal now used by simple locomotives, that materially reduces water consumption, diminishes boiler and slide valve repairs, reduces smoke, cinders and the fire risk, that steams better than the simple engine in hard places, without a necessary increase of any kind of repairs, must surely become the favorite as soon as people know which design to select.

Your committee has asked me to speak particularly of the *efficiency* of compound locomotives. This I propose to do briefly and as clearly as possible, and I shall begin with a statement of the reasons why a compound locomotive that is properly designed will save steam compared with the best simple locomotive, no matter what kind of service is considered.

1. The steam can be more conveniently used with great expansion, and therefore high steam pressure can be more advantageously utilized.

2. Division of the expansion between two cylinders diminishes condensation in both cylinders by reducing the range of temperature in each cylinder.

3. Division of expansion between two cylinders renders it possible to evaporate or reheat a portion of the moisture in the exhaust of the first cylinder, and thus render it capable of doing work in the second cylinder. As this can be done in the locomotive with waste gases the gain is all profit. By using the proper kind of receiver this is an effective means of economy.

4. Steam that leaks through the valve of the first cylinder is, in a properly designed locomotive, worked expansively in the second cylinder.

5. Steam that is re-evaporated toward the end of the high-pressure piston stroke, too late to work expansively, instead of being exhausted to the atmosphere as in the simple locomotive is worked expansively in the low-pressure cylinder.

Concerning the first reason, the expansion in the compound locomotive can be secured with a later cut-off than in the simple locomotive, and with this comes a wider port opening and less wire drawing of the steam. It is feasible to expand steam in a single cylinder by cutting off early, but such efforts have always resulted in wastefulness by great condensation. D. K. Clark showed as early as 1850 that a cut-off of about one-third stroke in a simple engine is the most economical, and the same thing has been recently shown by Professor Goss in this country. So that if a high degree of expansion is used in the simple locomotive it means extravagance in steam, although it may save some coal by low terminal pressure and gentle exhaust action on the fire. The compound locomotive, however, saves 15 to 20 per cent. of steam, and above this saves coal by its low terminal pressure and gentle exhaust.

Concerning range of temperature, in certain typical cases in my possession, the temperatures and ranges were as follows:

SIMPLE.		COMPOUND.			
Initial temp.....	374°	H. P.	368°	L. P.	312°
Lower.....	230°	"	298°	"	230°
Range.....	144°	"	70°	"	82°

In these cases the simple locomotive used 27½ pounds of feed water per indicated horse-power per hour, and the compound 19½ pounds, producing a saving of 29 per cent. This remarkable saving is attributable only to the small ranges of temperature in the cylinders with resultant small condensa-

tion, and to the reheating receiver, for the total expansion was the same in both cases.

In simple locomotives the condensation in cylinders sometimes amounts to as much as 60 per cent. of the total steam used, and in the case of a simple locomotive with which I have experimented, where the passages were well protected, the condensation was 38 per cent.

The effect of a reheater is rather difficult to determine in a locomotive, and of course no rise in temperature or superheating would be shown until all of the moisture had been converted into steam. As there is much moisture in exhaust steam, it is not likely that it will be all dried out by the receiver of a locomotive. In a pumping engine, however, such difficulty disappears, and in a Leavitt pumping engine at the Boston Water Works, while the pressure in the L. P. steam chest was equal to that of the atmosphere, the temperature instead of being 212° was 306°, showing the remarkable superheating of 94°. As a compound locomotive receiver is bathed in gases of 550° to 600°, while the temperature of the moist steam within has a temperature of only some 280°, it is unnecessary to argue that some re-evaporation takes place. When we remember the great capacity of the metal of a steam cylinder to condense and re-evaporate, we have ample reason for the belief that a receiver having a temperature fully 200° higher than that of any locomotive cylinder, has a much greater capacity for evaporating moisture than a cylinder. It is clear, from these considerations, that a receiver in the smoke box of a locomotive is of the greatest importance in promoting economy.

In the fourth reason for the economy of a compound locomotive I have stated that the leakage by the high-pressure valve should pass into the low-pressure cylinder, and be there worked expansively. This is necessarily so in the two-cylinder engine, but in some four-cylinder locomotives, with a single valve to two of the cylinders, leakage may pass directly from the high-pressure cylinder, or even the boiler, to the atmosphere.

While I have pointed out the economical advantages of compounding, I must not ignore the losses to which the compound is subject. These losses have in cases converted compounds into more wasteful engines than simples.

I will take up these losses as they occur. The first is that due to the imperfections of the link motion, which are strongly brought out in the high-pressure cylinder. These imperfections are great in simple engines also, notwithstanding the protestations of some of my locomotive friends, but in the H. P. cylinder of the compound, as compression begins on steam of receiver pressure, compression is likely to be excessive, and reduces the area of the indicator diagram seriously, and in early cut-offs at ordinary speeds, even, a loop is frequently formed showing negative work, thus reducing the net work. This is one reason why many compounds at certain points of cut-off do much more work in the low-pressure cylinder than in the high. It also furnishes a part of the reason why some compound locomotives are less economical, in relation to the simple engine, in light work than in heavy. In the latter case the point of cut-off is sufficiently late to avoid excessive compression and a loop in the diagram.

The usual remedies for this defect are, inside clearance to the slide valve, and large clearance volume in the cylinder. The former causes the exhaust to close later, thus trapping in less steam in the clearance spaces, and the latter gives a larger volume to fill by compressed steam, and thus reduces the maximum pressure. There is another remedy that ought to be applied in addition, as follows: The high-pressure valve should be set so as to give negative lead in full gear, and to give zero lead when cutting off at about 45 per cent. of the stroke. Slipping the eccentrics back sufficiently to accomplish this, delays the beginning of compression, and therefore its maximum amount.

Another loss, which is often great, is that between the cylinders, causing the combined indicator diagram to have a large gap between the bottom of the high-pressure and top of the low-pressure cards. This loss is so great in many cases as to amount to some 30 per cent. of the possible work of the steam after high-pressure release, and will nullify all gains that may come from compounding. It is probable that less than half a dozen compound locomotives in the country have this loss so small as to make it, when coupled with another phenomenon, virtually nothing.

I should not omit to notice a loss seldom thought of, viz., that due to the back pressure on the low-pressure piston. This piston always has a larger area than the combined areas of the two pistons of the equivalent simple engine. Unless the back pressure per square inch on the low-pressure piston is less than on the simple pistons, in proportion to the greater piston area, it is evident that the work of the back pressure is greater in the compound than in the simple engine. In general, I think the back pressure will be found to be proportionately less than in the simple engine, but this possible loss should furnish caution against over-cylindering a compound locomotive, especially on the low-pressure side, and particularly for high speeds. This is an argument for obtaining large power by means of large high-pressure cylinders, and indirectly for the cylinder ratio of 2 to 1, or thereabout, for a passenger engine.

Most compound locomotives have a low-pressure port ridiculously small, so small, in fact, that, while simple engines require an extravagant velocity of steam through ports, even as high as 1,500 feet per second, some compounds have it two to three times as great. In such locomotives the loss between the cylinders is enormous, and the engine becomes useless for high speeds.

This discussion has brought out the fact that the compound locomotive is subject to losses to which the simple engine is not, and which may render it unfit for fast work. Such defects can, however, be fully overcome by large and easy passages, and the oft repeated statement that the compound is fit only for freight trains is highly erroneous.

From one point of view compound locomotives can be divided into two classes, viz., the automatic, that starts by allowing live steam to pass to the large cylinder only until the engine has made a half revolution or thereabout; and non-automatic engines, that can be operated at will as simple locomotives as long as desired.

I have always taken the position that the non-automatic engine does not allow the compound system to fully realize its object, and that any locomotive which does not immediately become a compound after making an initial movement is to some extent a failure.

It is held by the advocates of this type that the automatic engine does not start well, and that it cannot pull a sufficiently heavy train over ruling grades. Neither of these features has come within my experience, although that has been with freight trains on a continuous grade of 96 feet per mile, 12 miles long, and with heavy fast suburban passenger work with 11 stops in 9 miles. It is no exaggeration, in fact, to say that the starting of the automatic engine has been uniformly surer than that of the simple engine in this service.

The point here considered is of the greatest importance in suburban or elevated railway work, for here the compound is particularly economical if it is a compound from the beginning. If it is a simple engine for some little time, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost.

From another point of view, compound locomotives are divided into two, three, or four-cylinder engines. Here appears a radical difference in detail, and one that must not be passed over without discussion.

In designing an engine for any kind of work it is fundamental that the smallest cylinders that will properly expand the steam should be used, and that the smallest number of cylinders should be used. By pursuing any other course more cylinder, piston and piston-rod surface is obtained than is necessary. As cylinder condensation is the greatest of all enemies of economy, by using multiple cylinders we invite our greatest enemy to be always with us. It is at least approximately true that cylinder condensation is proportional to surface, other things being equal, and dealing with common sizes, the cylinder, piston and piston-rod surfaces of a four-cylinder compound engine will be found to be about 33 per cent. in excess of those of the two-cylinder type. It is evident that the four-cylinder compound is therefore very seriously handicapped, when competing with the two-cylinder compound.

No further logic should be necessary to show that the four-cylinder compound cannot be justified from an economical standpoint, and has no reason for existence except as a means of producing a balanced engine.

If a two-cylinder compound requires a larger low-pressure cylinder than can be accommodated, two low-pressure cylinders can be used in its place, cast together, one above the other, and yet with advantage over the four-cylinder engine.

The economy on the elevated railway is due to the great amount of starting and acceleration of trains. The simple engine can only do this when working steam at full stroke or late cut-offs, while the compound engine will expand the steam some 2½ times when starting, and much more soon afterwards. Bearing in mind the great economy of steam gained by the early stages of expansion, the economy of the compound is evident. The following table shows the relative values of a pound weight of steam at different points of cut-off:

Point of cut-off.	Value of 1 lb. in weight of steam.
Full stroke	1.000
½ "	1.659
⅓ "	2.000
¼ "	2.207
⅕ "	2.343
⅙ "	2.435
⅐ "	2.495
⅛ "	2.532
⅑ "	2.552
1/10 "	2.560

This table shows that when the simple locomotive starts, it is using steam in such a way that one pound in weight does work of a value of 1, while the compound obtains from the same weight of steam work represented by 1.659 at least. In most cases it will be more than this, say, 1.768 for 2½ expansions. The saving in steam is therefore $\frac{1.768 - 1}{1.768} = 43$ per cent. Soon after, the simple locomotive is expanding the steam twice and the compound fully four times. The steam quantities are then 1.659 for the simple, and for the compound 2.207. The saving in steam is then $\frac{2.207 - 1.659}{2.207} = 25$ per cent. The actual savings made by some compounds in elevated service show that these figures are not far from the truth.

In express passenger service the quantities would be somewhat thus:

$$\frac{2.435 - 2.207}{2.435} = 9 \text{ per cent.}$$

The remainder of the saving in steam would come from the other causes mentioned in this paper, but chiefly from reduced cylinder condensation.

If we add to this effect the economy due to reduced cylinder condensation, and diminished ejection of sparks from the stack, the economy of the compound is still more marked, and it is evident that in elevated service the non-automatic compound loses a great part of these advantages.

The saving of fuel by the compound locomotive is materially affected by its increased evaporation per pound of coal, which amounts to some 15 per cent. Added to this a saving of some 15 per cent. in steam consumption, it appears an easy matter to save 30 per cent. in coal.

In closing, I desire to refer to the claim made by many persons that the saving by compounds is due to larger boilers and higher pressures. There have now been so many trials of engines of both types with boilers and pressures the same, that this view is gradually being abandoned. I have myself conducted trials of simple locomotives with pressures of 140 pounds, 160 pounds and 175 pounds, and have been unable to perceive any material difference in water consumption. Perhaps the most conclusive trials of this character were carried out by the Caledonian Railway in Great Britain, where the same engines have been tried with pressures varying from 150 pounds to 200 pounds, over long periods in the same service. I have been informed by the late locomotive superintendent of that line that their conclusion was that the most economical pressure for a simple locomotive is from 150 to 160 pounds.

The grand fact to remember in all of these considerations is that the compound locomotive can use as little as 20 pounds of steam per hour per indicated horse-power, while the simple locomotive cannot use less than 27 pounds, and in passenger work such a result for the compound can be attained by avoiding a net loss of work between the cylinders.

[For lack of room we defer publication of the discussion to a later issue.—ED.]

The Projectile Ahead This Week.

As we last week (page 371) had the pleasure of chronicling a test of a remarkable armor plate, of course the projectile must have its turn next. On May 1st, it will be remembered, a 13-inch Carpenter shell penetrated an 18-inch Carnegie Harveyized steel plate to a depth of 10 inches and was completely "pulverized." On May 8th, at Indian Head, a trial was had under the acceptance conditions for the contract trial of service shells. The last two lots of Carpenter armor-piercing projectiles for battleships were submitted for the ballistic test. They were required to pierce without injury 12 inches of solid steel; but as no common steel of that thickness was available, the target used was a 12-inch Harveyized plate, the ordnance experts being prepared to make allowance for the greater resistance of the hardened plate. Plates of this type were not in existence when the shells were ordered.

The first shot, with an initial velocity of 1,475 feet per second, penetrated the plate to a depth of 10 inches and went to pieces. It, however, knocked a big piece off the back of the plate, and the effect of the shot would have been most serious, if not fatal, to a vessel struck near the water line. This shot was sufficient to pass the shell under the contract, as it would have easily pierced ordinary metal.

Another shell, weighing 1,100 pounds, with a charge of 489 pounds of brown hexagonal powder and a muzzle velocity of 1,810 feet per second, went through the plate, the oak backing and the sand bank behind, and riccohetting high in the air, was carried a mile farther and was found to be practically uninjured.

A third shell, with 1,650 feet velocity, after piercing the plate, was found to have lost a strip of metal 11 inches by 3 inches, besides being upset, or, as the daily papers have it, "set up" by its contest with the plate.

The department will accept all the shells, as they more than fill the contract. There are no ships afloat, except our own, that they cannot penetrate. They cannot be relied upon to pierce more than 12 inches, and as all the great nations are now using the Harvey process, and are building vessels with a full knowledge of the 13-inch American "Peacemaker," we may next expect to be assured that the armor is ahead again. The demand is now for a solid projectile that will impart and still withstand a 30,000 foot-ton blow, with a soft metal cap that can fuse and act as a lubricator.

The Newport News Shipbuilding and Dry Dock Co. has contracted to build a steamer for the Plant steamship line, which will be more than 400 feet long and will cost about $600,000.

Setting Corliss Valves.

This article has been written in response to a number of our readers who have asked us to explain the method of setting the valves in a Corliss engine.

A brief description of the essential parts of this valve gear will assist in obtaining a clearer conception of the subject. In Figs. 1 and 2 similar capital letters of reference indicate the same parts of the mechanism.

Fig. 1 shows all the essential parts of the valve gear. The steam valves work in the chambers *S*, *S*, and the exhaust valves work in the chambers *E*, *E*. The double-armed levers *A C*, *A C*, work loosely on the hubs of the valve stem brackets and the lever arms *B*, *B*; the former are connected to

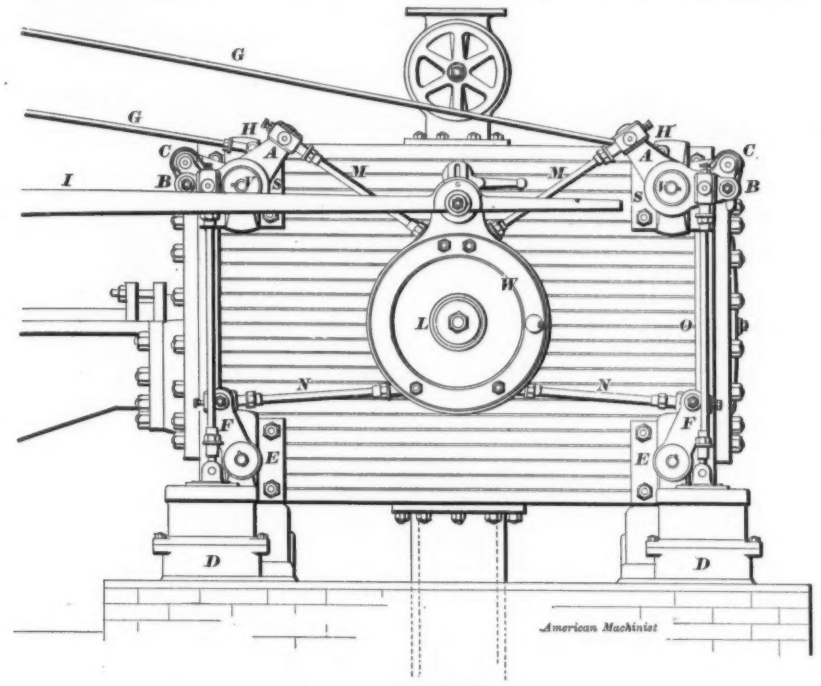


Fig. 1

SETTING CORLISS ENGINE VALVES.

the wrist plate *W* by the rods *M*, *M*; the levers *B B* are keyed to the valve stems *V*, *V*, and are also connected by the rods *O*, *O* to the dash pots *D*, *D*. The double-armed levers carry at their outer ends *C*, *C* hardened steel catch plates, which engage with arms *B*, *B*, making the two arms *B* and *C* work in unison until steam is to be cut off, at this point another set of levers *H*, *H*, connected by the cam rods *G*, *G* to the governor, come into play, causing the catch plates to release the arms *B*, *B*, the outer ends of which are then pulled downwards by the weight of the dash-pot plunger, causing the steam valves to rotate on their axes and thus cut off steam. These are the essential features of the Corliss gear, although the design of the mechanism is greatly modified by different builders.

The exhaust valve arms *F* are connected to the wrist plate by the rods *N*, *N*, and it is seen that all the valves receive their motion from the wrist plate; the latter receives its motion from the hook rod *I*; this rod is generally attached to a rocker arm, not shown, to this arm the eccentric rod is also attached. The carrier arm is usually placed about midway between the wrist plate and eccentric, and in the center of its travel stands in a vertical position.

The setting of the valves is not a difficult matter when, on the wrist plate, its support, valves and cylinder, the customary marks have been placed for finding the relative positions of wrist plate and valves.

Now, referring to Fig. 2, when the back bonnets of the valve chambers have been taken off, there will be found a mark or line *a* on the end of each steam valve *s*, *s*, coinciding with the working or opening edge of each valve; another line *b* will be found on each face of the steam-valve chamber coinciding with the working edge of the steam port. The exhaust valves and their chambers are marked in a similar way, *i. e.*, the line *g*, on the end of each exhaust valve, coincides with the working edge of the valve, and the line *h*, on the face of each exhaust valve chamber, coincides with the working edge of the exhaust port. On the hub of the wrist plate will be found a line *d* coinciding with the center line *d k*; lastly, there are three lines *f*, *e*, *f*, on the hub of the wrist-plate support, placed in such a way, that when the line *d* coincides with the line *e*, the wrist plate will stand exactly in the center of its motion, and when the line *d* coincides with either of the lines *f*, *f*, the wrist plate will be at one of the extreme ends *u* or *v* of its travel. It should be noticed that since the lines *f*, *e*, *f* are drawn on periphery of the hub of the wrist-plate support, and the line *d* is drawn on the periphery of the wrist-plate hub, these lines cannot stand in a vertical position, as shown; we have adopted this way of showing them, simply for the purpose of making the matter plain.

In setting the valves, the first step will be to set the wrist plate in its central position, so that the lines *e* and *d* will coincide, and fasten the wrist plate in this position by placing a piece of paper between it and the washer *L* on its supporting pin. Now set the steam valves so that they will have a slight amount of lap, that is to say, the lines *a*, *a* must have moved a little beyond the lines *b*, *b*; the amount of this lap depends much on individual preference and experience; it ranges from $\frac{1}{16}$ to $\frac{1}{4}$ inch for small engines, and from $\frac{1}{4}$ to $\frac{9}{16}$ inch for comparatively large engines. This lap is obtained by lengthening or shortening the rods *M*, *M* by means of the adjusting nuts.

Now place the exhaust valves *e*, *e*, by lengthening or shortening the rods *N N* by means of the adjusting nuts, in a position so that the working edges will just open the exhaust ports, or, in other words, place the lines *g* and *h* in line with each other. Some engineers prefer a slight amount of lap, others prefer a slight opening of the exhaust ports when the valves are placed in this position; under these conditions the lines *g* and *h* cannot be in line, but will stand apart, as indicated in the illustration; the distance between these lines will, of course, be equal to the desired amount of opening; for small engines it is about $\frac{1}{16}$ inch, and for larger engines may be increased to $\frac{3}{16}$ inch, but in any case the amount of this opening should be less than the lap of the steam valves, otherwise there will be danger of blowing through.

The paper between the wrist plate and the washer on the supporting pin should now be taken out, so that the wrist plate connected to the valves can be swung on its pin.

The next step will be to pay some attention to the rocker arm. Set this arm in a vertical position by means of a plumb-line, and connect the eccentric rod to it; then turn the eccentric around on the shaft, and see that the extreme points of travel are at equal distances from the plumb-line. To secure this a little adjustment in the stub end of the eccentric rod may be necessary. Now connect the hook rod *I* to its pin on the wrist plate, and again turn the eccentric around on the shaft, and thus determine the extreme points of travel of the wrist plate. If all parts have been correctly adjusted, the line *d* will coincide with the lines *f*, *f* at the extreme points of travel; if this is not the case, the hook rod will have to be adjusted at its stub end so as to obtain the desired equalized motion of the wrist plate.

The next step will be to set the valves correctly with the position of the crank; to do so the lengths of the rods *M*, *M*. *N* and *N* must not be changed, but the following mode of procedure should be followed: Place the crank on one of its dead centers, and turn the eccentric loosely on the shaft in the direction in which the engine is to run, until the steam valve nearest to the piston shows an opening or lead of $\frac{1}{32}$ to $\frac{1}{8}$ inch, according to size of engine, the smaller lead, of course, being adopted for small engines. After the proper lead has been given to this valve, secure the eccentric, and turn the shaft with eccentric in the same direction in which the engine is to run until the crank is on the opposite dead center, and notice if the opening or lead at this end of the cylinder is the same as on the other steam valve; if not, shorten or lengthen slightly, as may appear necessary, the connection between wrist plate and eccentric; of course much adjustment in the length of these connections is not admissible without resetting the valves with reference to the wrist plate.

The only thing which remains now to be done is to adjust the cam rods *G G*. To do so, secure the governor balls in their highest position, and disconnect the hook rod from wrist pin; lengthen or shorten the cam rods *G*, *G*, so as to bring the detachment apparatus into action, swing the wrist plate back and forward and make such adjustment in the rods *G*, *G*, as to permit the steam valves to be released when the steam port has been opened about $\frac{1}{8}$ inch. This adjustment is for the purpose of keeping the engine under the control of the governor, in case, for some reason or another, the load on the engine is suddenly thrown off. After this adjustment the governor balls should be placed in their lowest position, in which the releasing gear should not detach the steam valves, but allow the steam to follow nearly full stroke. Sometimes the releasing gear is constructed in such a manner as to close the steam valves automatically, in case the belt leading to the governor should be

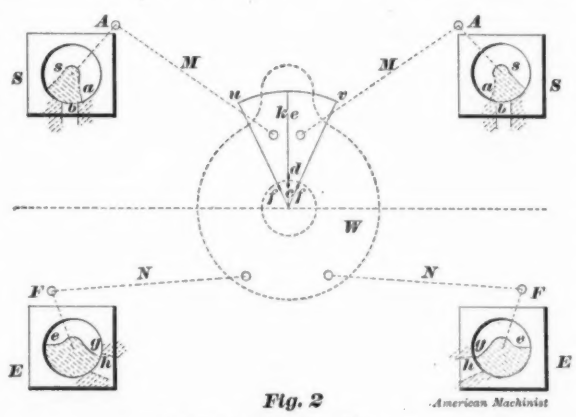
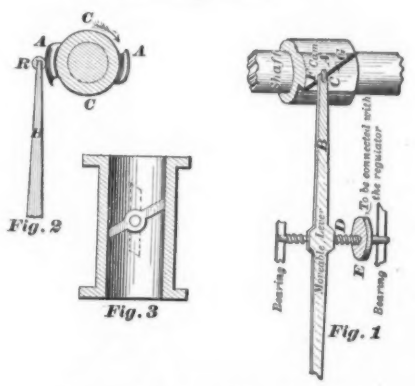


Fig. 2

SETTING CORLISS VALVES.

broken, or the load on the engine suddenly thrown off. In cases of this kind the governor balls need not to be placed in their highest position, but should be placed in their lowest position, and the wrist plate moved to either end of its extreme travel; the steam port opposite this end of travel of wrist plate will then be wide open, now adjust the corresponding cam rod so that the releasing gear is nearly on the point of releasing the valve; then move the wrist plate to other end of its extreme travel, and adjust the other cam rod in the same manner. To prove the correctness of the cut-off adjustment, raise the governor balls to about a position where they would be when at work, or to a medium hight, and block them there; then, with the connections made between the eccentric and the wrist plate, turn the engine shaft slowly in the direction in which it is to run, and when the valve is released, measure upon the slide the distance through which the crosshead has moved from its extreme position. Continue to turn the shaft in the same direction, and when the other valve is released, measure the distance through which the crosshead has moved from its extreme position, and if the cut-off is equalized, these two distances will be equal to each other. If they are not, adjust the length of the cam rods until the points of cut-off are at equal distances from the beginning of the stroke. Replace the back bonnets and see that all connections have been properly made, which will complete the setting of the valves. Wherever convenient, it is desirable that an indicator be applied to the engine when at work, and the setting of the valves tested. If necessary, they should be re-adjusted for the best possible condition for economical work.



Zachariah Allen's Cut-off.

The death of Frederick E. Sickels has brought his invention of the detaching valve gear into prominent interest, and has also brought forward the names of all who had, previous to the devices contrived by Sickels, worked along the same lines of thought which the illustrious inventor of the drop cut-off pursued.

The most successful of all Sickels' predecessors in the search for perfect steam valve handling methods, was undoubtedly Zachariah Allen, who put what he called his "variable and detachable cut-off steam valve" in practical operation in the Wadsworth Steam Engine Works, Providence, R. I., in the year 1834, thus preceding Sickels by some six or seven years.

In a letter written by Allen to Corliss, dated Providence, February 3d, 1870, Allen says that Corliss patented his (now universally known) valve and valve gear in 1849, and invented it in 1848; and further says to Corliss, "You have frequently seen the large steam engine in the print works constructed by my brother, Philip Allen, near your office in Providence, and now under my charge, and are aware that it has been operated by the use of a ball regulator" (governor) "applied to produce a variable and detachable cut-off movement, as described in my patent, and in the improvements patented by Mr. Sickels, independently of the use of a throttle valve, and" (also independently of) "of any of your claims for steam-engine patents."

The precise state of the art of regulating the speed of steam engines previous to the inventions of Allen was this: the cut-off was well known; cut-off gear was applied to steam-engine valves by Watt; and there were modifications which could vary the point of cut-off, the change being made by a different disposition of parts which could be effected only when the engine was standing still; hence the engine was, when at work, subject to the influence of cut-off at a fixed point only; and this fixed cut-off had no speed-regulating effect on the engine whatever. To regulate the speed, Watt invented the ball governor now universally used, and connected the governor to a "butterfly" valve, of the general form shown in Fig. 3. The butterfly valve is very easily made, is not quite tight, and is perfectly balanced except when standing in closed position; it can be supported on a small stem which moves with little friction;

it was the favorite, or perhaps only governor valve used by Watt, its action being of course simply to throttle the steam. The butterfly valve was also often used as throttle valve to be operated by hand for stopping and starting the engine, though never to my recollection without a screw or slide valve between the butterfly throttle and the boiler, because the leakage of the butterfly rendered it unsafe as a sole dependence for a stop valve. Such was the condition of the art when Allen's attention was drawn to the inherent faults of the throttling governor. Allen therefore, retaining the butterfly valve, put two long wedge-shaped cams on the engine shaft, as shown in Fig. 1, and made a connection between the roller, under which this wedge-shaped double cam traveled, and the butterfly valve stem, and contrived a means by which the governor could shift the cam roller toward the point of the wedge cam when the engine raced, and toward the thick end of the wedge when the engine lagged. The extreme cut-off was fixed by the number of degrees of the circle occupied by the thick end of the wedge. As will be seen by the end view, Fig. 2, the rise of the cam and consequent opening time of the valve was quick. The closing time of the valve would, of course, depend on the diameter of the cam roller *R*, Fig. 2. If the cam roller were taken away altogether, then the parts might be so shaped that the butterfly cut-off valve would *really* "drop." As shown in Fig. 2, however, the valve would not drop. Fig. 1 shows the means by which the roller traverse over the cam length was had. This drawing is signed "H. W. Parkhurst," and was probably made to form an exhibit in the argument of the remonstrants against the granting of the application for the extension of the Corliss patent in 1870, which Corliss had already held for 21 years, and which had brought him a fortune.

In this same February 3d, 1870, letter to Corliss, Allen says of the print works engine: "This steam engine has been in operation during the whole term of fourteen years of your outstanding patent claims, and is now operating excellently well, with an economy of coal and a perfection of effective power, as indicated by diagram, unsurpassed, as I believe, by any engine of your construction."

It is true that the butterfly valve is so seldom quite tight, that it may be said to never be so; but when the experience of Corliss with the "Hope" station pumping engine is recalled, it will be seen that the butterfly valve was perhaps at least equal to the "Hope" Corliss valves in the point of tight closing.

Corliss built the unique six-cylinder "Hope" pumping engine under his own guarantee to equal a 55,000,000 duty, which was the performance of certain Worthington pumping engines. The unique 6-cylinder upon trial, however, showed something under a duty of 20,000,000. After a year of experiment, Corliss pulled the valves out of the "Hope" engines and put in new ones, which were made tight as good work and care could produce, and with these new valves the Hope engine showed a duty of 36,000,000, or nearly double its previous performance, which tends to show that in some cases Corliss himself failed to make the Corliss valve tighter than a well-fitted butterfly can be made.

Zachariah Allen must be given the great credit of having first put the time of the cut-off under control of the governor of a steam engine by the use of durable and efficient mechanical elements. He reached a high economy in the use of steam, and his true place is with the foremost of steam-engine improvers. CARL NORLAND.

NEW CATALOGS.

We have received from the Taunton Locomotive Mfg. Co., Taunton, Mass., a catalog containing 25 illustrations showing various forms of the Wainwright appliances, that is, feed-water heaters, surface condensers and expansion joints. No one interested in steam plants can fail to find information of value in this catalog.

We have received from C. P. Monash, manager of the Van Aucken Steam Specialty Co., 201-207 S. Canal street, Chicago, Ill., "Catalog A," in which is illustrated and described improved air valves for steam heaters, steam traps, pump governors, low-water alarms for steam valves, and similar appliances. If this catalog were ¼ inch larger each way it would be standard size (6"x9").

We have received from W. D. Allen & Co., 151 Lake street, Chicago, Ill., a large catalog of belting and rubber goods. This is devoted more particularly to the illustration and description of such rubber goods as are used in manufactories, but there is much else in the way of valves, water gauges, steam whistles, water columns, lubricators, oil cups, etc. There is also a telegraph cipher code, and considerable useful information to buyers of factory supplies.

We have received from the C. W. Hunt Co., 45 Broadway, New York, "Catalog No. 9,503," which is devoted to illustrations and description of industrial railways and their equipment for manufacturing establishments. Anyone interested in the economical handling of materials and manufactured products will find this catalog useful, and with it are enclosed some small tables giving figures regarding rope driving and a metric conversion table, arranged by Mr. C. W. Hunt. These also will be found convenient to engineers.

We have received from the I. P. Morris Co., Philadelphia, Pa., which is owned and controlled by The William Cramp & Sons Ship and Engine Building Co., a pamphlet in which full particulars are given of the duty trial of a pumping engine for the Louisville Water Co., Louisville, Ky. The trial was conducted by Dexter Brackett, Expert for the I. P. Morris Co., and F. W. Dean, Expert for the Louisville Water Co., and shows a result very creditable to the engine and its builders. The pamphlet also contains a reprint of Mr. Dean's paper read before the American Society of Mechanical Engineers in December, 1894, in which he describes this test, and also his paper describing the engine test at Natick, R. I., built upon the system of Mr. Geo. I. Rockwood. This is sufficient to show that the pamphlet contains much matter that is of interest to engineers, and we understand that it is sent to those interested, upon application.

MANUFACTURES.

The Newburyport (Mass.) Iron Foundry and Machine Works will enlarge its works very shortly.

The Marsh-Hight Mfg. Co., of St. Louis, Mo., has been incorporated by W. L. Becker and Geo. B. Hight.

The Clifton Tack Works, of Baltimore, Md., has been organized, and will erect a plant E. V. Cordell is interested.

It is said that a cotton-mill will be erected at Abbeville, S. C. Among those interested are P. Rosenberg and A. W. Smith.

The Morris Cotton Mills Company has been organized at Central, S. C., with D. K. Morris as president. Its capital stock is $70,000.

The Hillsborough Cypress Co., Harney, Fla., has been organized by Thos. H. Walker and Giles M. Wing, with capital stock $100,000.

The new crematory building at the Brooklyn Navy Yard is now being put up by the Berlin Iron Bridge Co., of East Berlin, Conn.

Frank Costillo and others of Chattanooga, Tenn., will shortly organize the Ornamental Steel and Wire Works with a capital stock of $10,000.

L. Best, the sole New York agent for the Sterling Emery and Corundum Wheels, has removed from 174 Fulton street, New York, to 45 Vesey street.

It is stated that the plant of the Frankton (Ind.) Tin Plate Co. will be completed and ready for operation by September. The company will employ 300 men.

The West Georgia mills, of La Grange, Ga., has been incorporated. The capital stock is $200,000. A new mill will soon be erected. J. E. Dunson is interested.

The Webster & Ring Mfg. Co. has been formed in Bangor, Me. The capital stock is $80,000. The officers are: President, J. F. Webster; secretary and treasurer, E. C. Webster.

The St. Louis (Mo.) Fernholz Brick Press Co. is the name of a new concern which has been incorporated by Emil Fernholz and Arthur E. Kamerer to make brick machines.

The Van Choate Electric Co., Foxboro, Mass., has started work on its large building, and work will be pushed rapidly forward, and the buildings will be completed by the middle of the summer.

Speidel & Roeper, Reading, Pa., who manufacture elevators and hoisting machinery, report business good, and the outlook encouraging. They send a list of sales for April sustaining their view of the matter.

Mr. Geo. E. Affleck, who has been connected with the Prentiss Tool and Supply Co., will take charge of the New York branch of the Lodge & Davis Machine Tool Co., and will carry a large stock of their tools at 110 Liberty street, New York.

The new machine shop for the Goulds Manufacturing Co., at Seneca Falls, N. Y., will be designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn. The building, as designed, will be constructed with a steel frame, and will be provided with a 15-ton traveling crane.

The Jones & Lamson Machine Co., Springfield, Vt., mention among the jobs now in their shops, some flat turret lathes fitted for the special work of the Meihle Printing Press and Mfg. Co., and state that they have recently shipped two of their regular machines with complete outfits to the Russian Gun Works.

Early last week the Manufacturer's Tool Supply Co., of 17 S. Canal street, purchased the name and good will of the Machinist's Supply Co., of Chicago. The business will be carried on under the name of "Machinists Supply Co.," at 17 South Canal street, and the management will be identical with that of the Manufacturer's Tool Supply Co. They have refitted the store, and re-stocked it with the latest designs in tools. F. Mathieson is manager of Manufacturer's Tool Supply Co.

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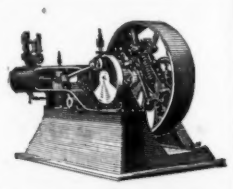

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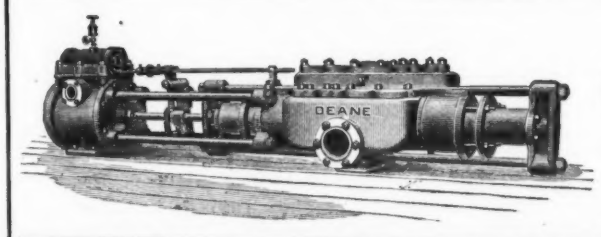

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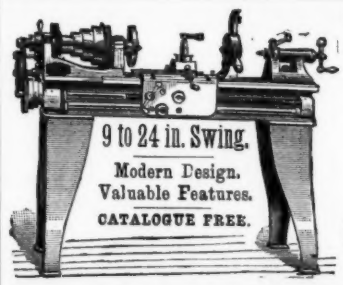

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Machinists' Supplies and Iron.

NEW YORK, May 11, 1895.

Iron—American Pig—We quote standard brands, $12 to $12.50 for No. 1; $10.75 to $11.25 for No. 2; and $10.25 to $10.50 for No. 2 Plain. Southern brands, $11.25 to $11.50 for No. 1; $10.75 to $11 for No. 2; $10.50 to $10.75 for No. 3; $10.75 to $11 for No. 1 soft; $10.50 to $10.75 for No. 2 soft; and Foundry No. 4, $10 to $10.25.

Antimony—There is but a slight change in the market, the only business done is at retail. We quote L. X., 8¼c. to 8¾c.; Cookson's, 8¼c. to 8¾c.; Hallett's, 7.05c. to 7.10c; U. S. French Star, 7½c., and Japanese 6.90c. to 7c.

Lard Oil—Prime City we quote at 53c. to 54c.

Copper—The market is strong and prices have advanced. For Lake Copper 10¼c. to 10.15c. has been paid for large quantities, and 10⅛c. to 10¼c. is now quoted. Casting Copper is quoted at 9½c. to 9⅝c.

Lead—There is no important change in the market. For prompt or near future deliveries 3.07½c. to 3.10c. is asked.

Spelter—The market shows a slight improvement and prices are firmer and have advanced. Sellers are asking 3.40c. to 3.45c. for New York delivery.

Tin—The market is steady and prices have advanced: For prompt and current month delivery 14.40c. is asked.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Mech. draftsman, exp., good designer, wants situation. Address Box 184, AMERICAN MACHINIST.

Young M. E. with exp. wants pos. as designer of steam engs. or gen. mach. Box 185, AM. MACH.

Wanted—An exp'd duplex pump salesman. Address, giving particulars, Duplex Pump, AM. MACH.

A member of the A. S. M. E., with 14 yrs. exp., desires a pos. as supt., manager, or other responsible office. Address Energetic, AM. MACHINIST.

Wanted—By young mach., work at tool-making under instructions; small pay expected. Box 183, AMERICAN MACHINIST.

Wanted—Position by an all-round machinist; repair work preferred, or as stationary engineer, good references. Box 193, AMERICAN MACHINIST.

Turret lathe hand, 2 yrs. on Jones & Lamson 2x24 flat turret lathe; 9 yrs. on screw mach. work, wants position; refs. Box 192, AM. MACHINIST.

Head draftsman, experience chiefly on tools, must take work of some kind at once. At references. "T.", AMERICAN MACHINIST.

Wanted foremanship, by one having a wide experience with general jobbing; generators, dynamos, and engines. Indicator, care AM. MACHINIST.

Practical machinist and draftsman, 25 years' experience in large scale works as foreman and master mechanic, desires change; large exp. in special mach. and jigs to reduce cost. E. H. W., AM. MACH.

Wanted—Foreman for a machine shop employing 50 to 75 men; must be thoroughly posted in modern machine shop practice and a hustler; no other need apply. Address T. M., AM. MACHINIST.

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An energetic man to represent us in N. Y. City; one connected with the boiler or steam pipe business preferred. Holly Steam Engineering Co., 344 Butler Exchange, Providence, R. I.

Patternmaker who knows his business, is 12 yrs. foreman in present pos., wants a change; would take pos. as instructor in trade school. Box 191, AMERICAN MACHINIST.

Wanted—A 1st-class draftsman, familiar with designing high duty pumping machinery of the most modern design. Give age, exp. and ref., and state salary expected. L. D. G. Co., Cincinnati, Ohio.

Wanted—Mech. dftsman with prac. exp. in shop work; must be well informed on tools and small interchangeable work. State where previously employed, salary expt'd and age. M. M., AM. MACH.

Wanted—An energetic foreman for a mfg. machine shop; must understand pushing productions and handling help, as well as building mach'y. A self-reliant man with a record preferred. State age, exp. and salary expt'd. Box 186, AM. MACH.

Working foreman wanted as ass't to mechanical supt. of factory manufacturing buggy axles and springs; must be exp'd in axle work, capable of taking charge of works. State age, experience and salary expected. Box 188, AM. MACHINIST.

Wanted—A good blacksmith as tool dresser for a large machine shop, who thoroughly understands his business. When writing, give age, references, and whether married or single. Address Box 190, care AMERICAN MACHINIST.

✣ MISCELLANEOUS WANTS ✣

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

(*Continued on Page* 394.)

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3	3/4	.50	9	2½	1.40
4	1	.60	10	3	1.50
5	1¼	.75	11	3½	1.70
6	1½	.85	12	4	1.90
7	1¾	1.00	Full set of 12—12.00		

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These goods are for sale by CHAS. CHURCHILL & CO., L'd'd, 21 Cross St., London, England.

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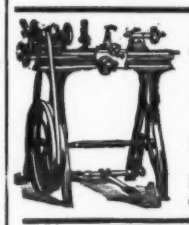

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9 and 12 inch Swing.
New Designs. Novel Features.
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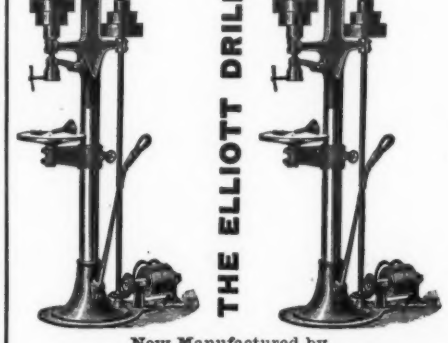
LARGE RANGE OF WORK—LOW PRICE.



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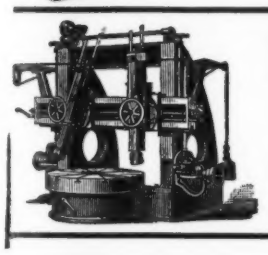

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14 SIZES FROM 5 TO 20 FEET.
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To Send for My Catalogue and Special Prices on "Caliper Gauges."
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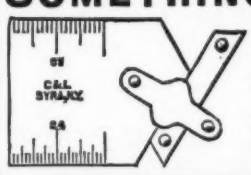

Adjustable Notch Centre Gauge.
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Washington, Wm. B. Morgan, Room 19, Builders' Exchange.
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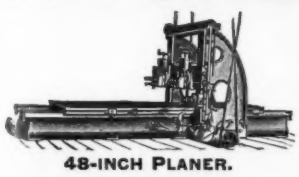

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GOOD 2d HAND TOOLS.

FITCHBURG MACHINE WORKS, FITCHBURG, MASS.

MANUFACTURED BY

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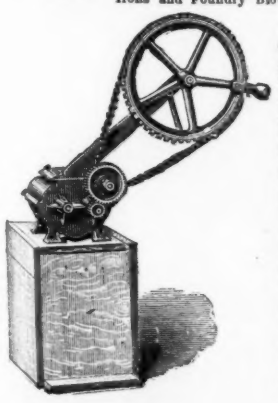
We can guarantee that our castings will be uniform and of high tensile strength.
Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "

ROOTS' NEW ACME HAND BLOWER.
For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.



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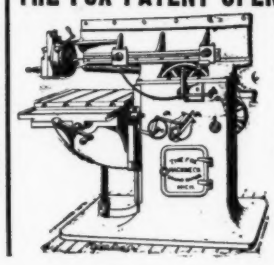

No springing of ram. No overhanging table. Quick Return, Stroke Under Perfect Control. Can be Instantly Adjusted 1-16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.
The Fox Machine Co.,
325 N. Front St.,
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JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
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WM. JESSOP & SONS, LTD.
Established a century ago.
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FOR EXPENSIVE TOOLS
Bohler Bros. Styrian Tool Steels
Will be found to be the cheapest and best if wearing qualities are considered.
HOUGHTON & RICHARDS,
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WORTHINGTON CONDENSERS.
AGGREGATING IN CAPACITY
625,000
HORSE POWER
ARE NOW IN USE.
SEND FOR SPECIAL PAMPHLET.
HENRY R. WORTHINGTON,
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✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Bicycle Repair Outfit. Send 6 cents postage for full illus. catalog. Frasse, 17 Warren St., New York.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

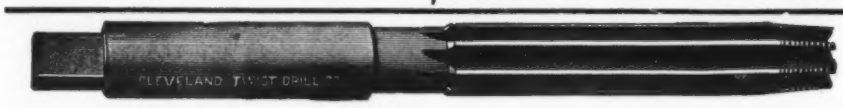
Wanted—A set of tracings or blue prints for tenton electric crane, 40-foot span. Reply, with prices and details of type, to Box 189, AMERICAN MACHINIST.

Wanted—A new, also a second-hand shaper, 15 or 20 inches; must be good, and cheap State condition, and terms. Asa P. Hyde Machinery Agency, Oxford, Chenango Co., N. Y.

For Sale or Trade—Complete plant, foundry, machine shop, tools and stock (established 10 yrs, and paid good dividends) in one of the best agricultural States of the West, making a specialty of grain elevator and mill mach'y, and in close proximity to mining districts. Good railroad facilities. Address W. 2, care AMERICAN MACHINIST.

To Marine Work Iron Founders—The patentee of an improved propeller wheel molding machine (Pat. No. 532 460) warranted to make any size or pitch either by steam power or hand, desires floor room in a suitable foundry, to erect this machine, and also facilities for demonstrating the capacity of same. Address Louis His, 236 South Park street, Elizabeth, N. J.

For Sale—Instruments and books, "Elliott's" gas apparatus, complete, W. S. Robinson's "templet odontograph," D. K. Clark's data for mechanical engineers; Appleton's "Encyclopedia Applied Mechanics," complete; Groves and Thorp "Chemical Technology," Vol. I, "Fuels"; Prof. Rankine's "Civil Engineering," "Steam Engine," "Machinery and Millwork," "Applied Mechanics" (4 books). Also other works from standard authors; will be sold very cheap. Address Mrs. O. S. Lanphear, 967 Dennison avenue, Columbus, Ohio.



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CLEVELAND TWIST DRILL CO.

COR. LAKE & KIRTLAND STS. CLEVELAND, O.

100 & 102 Reade Street, New York.
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LARGE TOOLS

At special low prices before removal.

PLANER, 64 in. wide, 64 in. high, 10 ft. long. Good order, "Pond's make."

PLANER, 60 in. wide, 60 in. high, 20 ft. long. Good order, heavy pattern, "Steam Eng Co.'s make."

PLANER, 36 in. wide, 33 in. high, 14 ft. long. Good order, "modern style."

PLANER, 30 in. wide, 30 in. high, 10 ft. long. Good order, "Harrington's make."

LATHE, 72 in. swing, 20 ft. bed, triple geared, screw feed and compound rest. Good order.

LATHE, 48 in. swing, 16 ft. bed, triple geared, screw feed, compound rest, cross feed and chuck jaws, "N. Y. Steam Engine Co.'s make."

LATHE, 24 in. swing, 14 ft. bed, rod and screw, cross feed and chuck, "Lathe & Morse make."

HAPER, traveling head, 14 in. stroke, 28 in. feed, centers, circular feed and chuck, "Fitchburg make."

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BOILER ROLLS, 10 ft. with hinged housing, improved style. Good as new.

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14 in. x 4 ft. Blaisdell, Taper.
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37 in. x 14 ft. maker unknown.

PLANERS.
16 in. x 16 in. x 4 ft. Hendey.
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12 in. Juengst, Crank.
15 in. Juengst Friction.
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18 in. Putnam, Traverse Head.
18 in. Smith & Silk, Crank.
21 in. Smith & Silk, Shifting Belt.
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24 in. Hendey, Friction.

HAND LATHES.
4 10 in. x 41 in. Garvin.
1 12 in. x 4 ft. Stewart Pattern.

HAND LATHES.
1 12 in. x 5 ft. Pratt & Whitney.
1 12 in. x 5 ft. Back Geared.
1 20 in. x 8 ft. " "

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Garvin Profiler, one spindle.
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5 in. Cutting-off Machine.
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No. 1 Brown & Sharpe Screw Machine.
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21 in. Squaring Shear.
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250 lb. Gould & E. Drop Press.
100 lb. Stiles Power Drop Press.
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No. 31 Eaton Double-acting Press.
No. 2 Garvin Wire Spring Coiler.
Several Woodworking Machines.

Also, a large number of other machines. Write for complete list, detailed descriptions and prices.

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FOR SALE.

10-TON TRAVELING CRANE,

46 ft. Span, Rope Transmission,
Also 54 in. Colliau Cupola.

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BEFORE REMOVAL

At Phœnix Iron Works, Trenton, N. J.

15 in. x 6 ft. Engine Lathe.
18 " 8 " " "
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29 " 13½ " " "
26 " 20 " " "
29 " 12 " " "
37 " 30 " " "
51 " 20 " " "
51 " 18 " " "
72 " 20 " " "

Steam Hammer, F. & M., 1,000 lbs.
19-36 and 50 in. Drills.
Portable Drill.
24 in. x 5 ft. Planer.
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36 in. x 12 ft. Planer, 2 Heads.
Bement Slotter 19 in. Stroke.
2 in. Bolt Cutter.
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Gear Cutter, 54 in.
Milling Machine.

10 ft.-16 ft. Vertical Boring and Turning Mill, Cranes, Blower, Boiler Rolls, Punch and Shear, etc.

Send for full list and prices.

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TO BUY FOR CASH.

First-class Second-hand Engine Lathes, Planers, Drill Presses, Shapers, Milling Machines, etc., address,

The Fosdick & Plucker Machine Tool Co.,
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BUILDERS OF

PIN, SAFETY PIN, HOOK AND EYE MACHINERY,

AND LABOR-SAVING MACHINES OF EVERY DESCRIPTION.

Bent Wire Goods a Specialty. Send Samples that we may quote prices for either machine or the Goods.

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OWNERS OF
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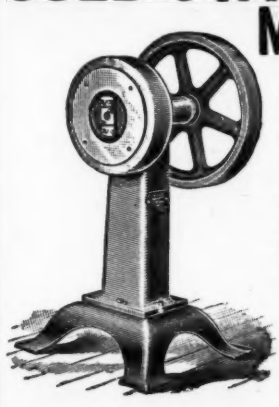

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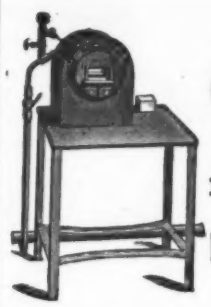

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For the economical generation and systematic application of HEAT.

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OF
New Planers

At our Chicago Store to reduce stock.

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One Draper Planer, 26" x 25" x 6 ft.
One New Haven Planer, 24" x 20" x 4 ft.
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HILL, CLARKE & CO.,
Machinery Merchants,
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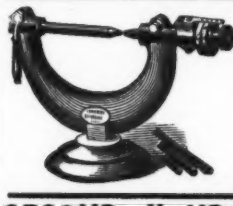
MACHINERY FOR SALE.

12 H. P. Vertical Engine and Boiler, second-hand.
20 " " " " " " "
Roots' Pressure Blowers Nos. 1, 2 and 6, " "
Open-die Bolt Cutter, cuts up to ¾ in., " "
" " " " " " 1¼ " " "
Lot 6⅛ and 7⅛ in. Shafting, Pulleys and Bearings, nearly new, at less than half value.

COOKE & CO.,
163 and 165 WASHINGTON ST., NEW YORK.

CHARLES H. BESLY & CO.
SOLID OIL
TRADE MARK
REGISTERED
CHICAGO, ILL. U.S.A.
HELMET OIL
USED BY THE BEST ENGINEERS: THEY INSIST ON HAVING IT:— THE CHEAPEST LUBRICANT KNOWN:— PUREST AND BEST FOR ALL KINDS OF MACHINERY.
SEND FOR 250 PAGE ILLUSTRATED CATALOGUE
CHARLES H. BESLY & CO.
METAL WORKERS TOOLS AND SUPPLIES
10 & 12 N. CANAL ST. CHICAGO, ILL. U.S.A.



SWEET'S Measuring Machine.

The only micrometer that will not lose its accuracy by wear.

Satisfaction Guaranteed,

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Syracuse, N. Y.

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Ballou Tool Room Lathe, with chucks and all parts complete. No. 1 Brown & Sharpe Universal Milling Machine. Universal Cutter and Reamer Grinder. Heavy Ferracute Press. 32-inch Pond Planer. 4-spindle Power Feed Drill.

The above tools are as good as new.

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Below will be found a partial list of the Pratt & Whitney Co.'s machine tools which were recently, and for a very short time, in use by the Paige Compositor Mfg. Co., of Chicago. Some of this machinery has been used scarcely at all. We have purchased all that part of the equipment which is of OUR OWN MAKE and offer it at attractive prices. Part if not all of it can be seen in our Warehouse, S. E. Cor. Washington and Clinton Sts., Chicago, Ill.

12 16 in. Planers, 3 ft. Table.
4 16 in. " 4 "
2 20 in. " 5 "
6 20 in. " 6 "
4 No. 2½ Hand Milling Machines with Vise.
10 No. 0 Power " " " " "
4 No. 1 " " " " "
4 No. 1 " " " " " and [Long Table.
1 Index Milling Machine.
6 No. 2 Upright Drills.
2 9 in. 3½ ft. Hand Lathes, Morse Taper.
3 12 in. 5 ft. " " " "
4 13 in. 6 ft. Plain Back-Geared Lathes, Power Feed, Morse Taper.
2 13 in. 6 ft. Weighted Screw Lathes, Morse Taper.
2 13 in. Gibbed Screwed Lathes, Compound Rest, Morse Taper.
2 16 in. 8 ft. Bed, Plain Back-Geared, Power Feed Lathes.
2 16 in. Weighted Screw-Cutting Lathes.
2 16 in. 7 ft. Gibbed Screw-Cutting Lathes.
2 16 in. 8 ft. " " " "
2 16 in. 9 ft. " " " "
4 9 in. Pillar Shapers, without Vise.
4 9 in. " " with Vise.
4 14 in. " " without Vise.
4 14 in. " " with Vise.
2 No. 1 Screw Machines, Wire Feed.
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1 No. 3 " " " "
1 14 in. Chucking Machine.

PRATT & WHITNEY CO.,

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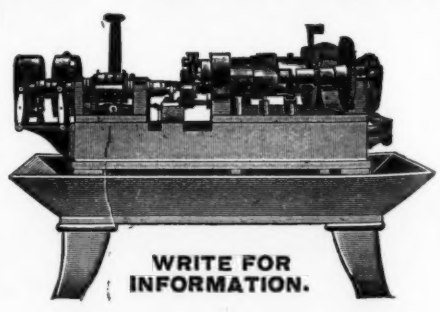
Branches: BOSTON. NEW YORK. CHICAGO.

STEEL BALLS

For all Anti-Friction Purposes.

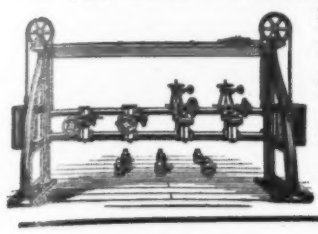


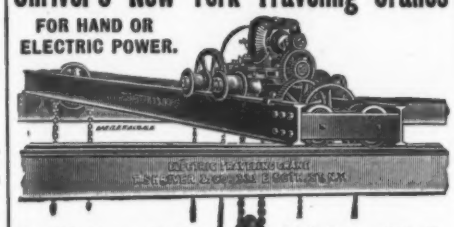
WE ALSO MANUFACTURE

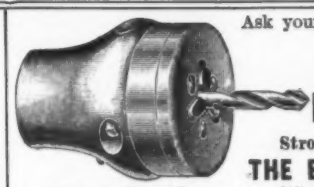
AUTOMATIC SCREW MACHINES
AND
SCREW MACHINE PRODUCT
OF EVERY DESCRIPTION.

Cleveland Machine Screw Co.,
CLEVELAND, OHIO.

WRITE FOR INFORMATION.

THOS. H. DALLETT & CO.,
YORK ST. & SEDGLEY AVE., PHILADELPHIA.
MANUFACTURERS OF
Portable Drills, Hand Drills, Boiler Shell Drills, Light Drill Presses.
Also ELECTRIC MOTORS

for driving Machine Tools, Cranes, Elevators, Pumps, Presses, and other Machinery.

Shriver's New York Traveling Cranes
FOR HAND OR ELECTRIC POWER.

T. Shriver & Co. 333 East 56th St., NEW YORK.
MANUFACTURERS OF
TRAVELING CRANES of 1½, 2, 3, 5 and 10 Tons capacity, to be operated by Hand, or wholly or in part by Electricity.

Ask your nearest Dealer, or send to the Manufacturers for

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Strong, Accurate, Durab'e, Cheap,
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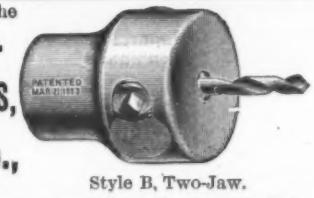
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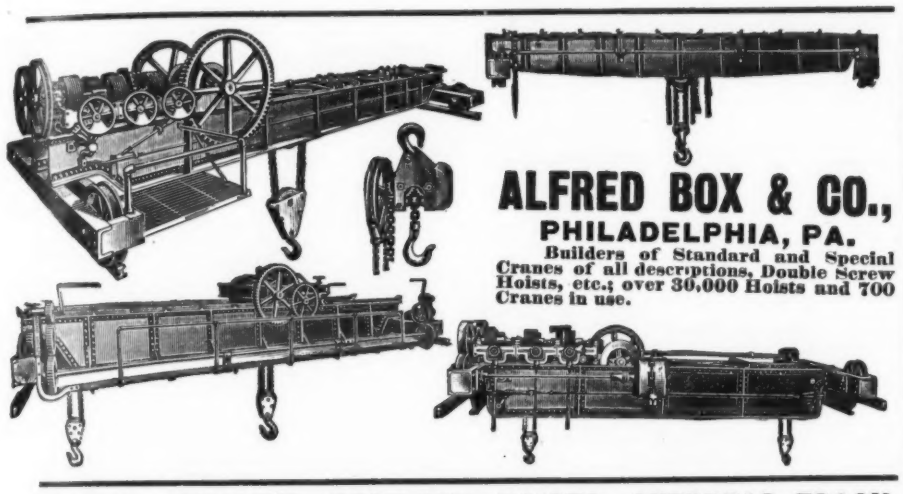
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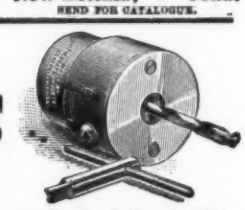
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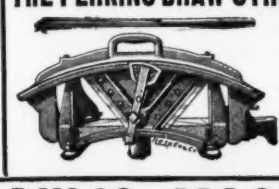
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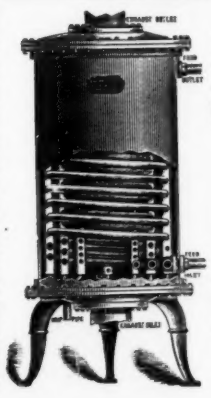
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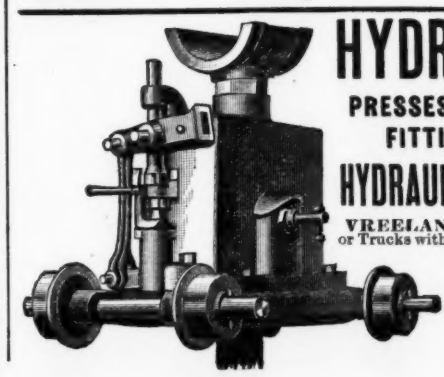
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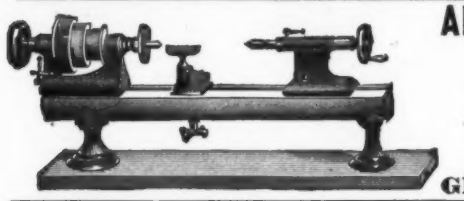

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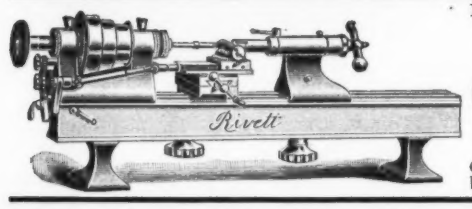

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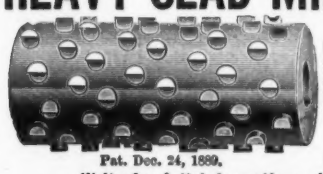

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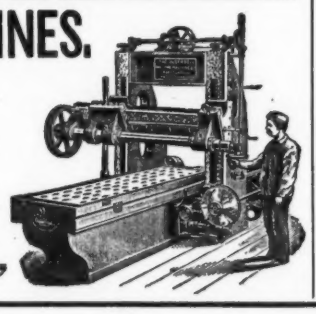

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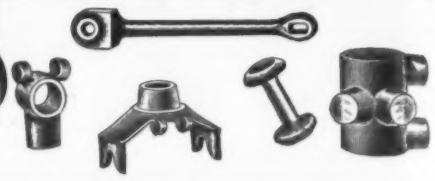

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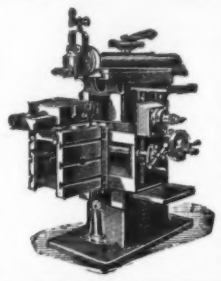

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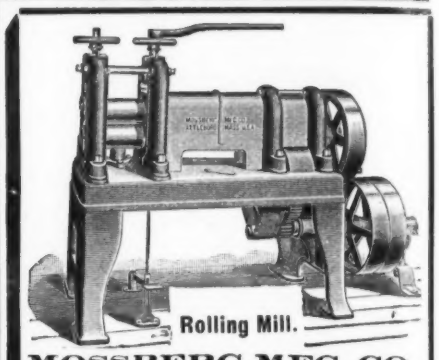

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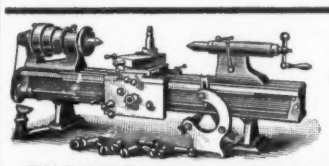

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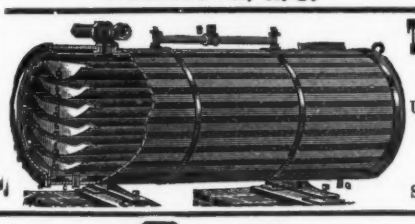

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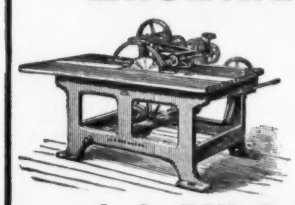

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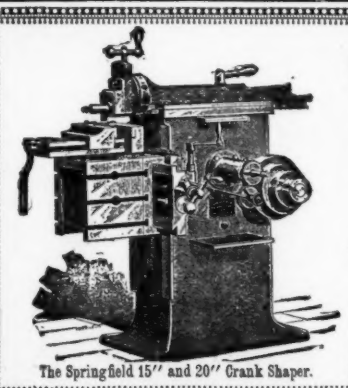

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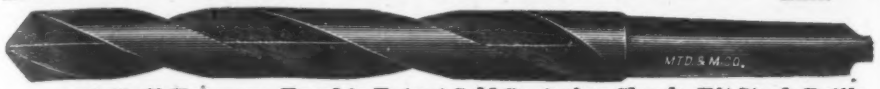

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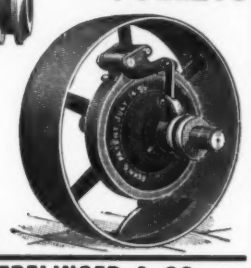

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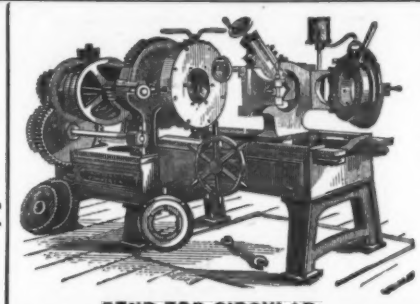

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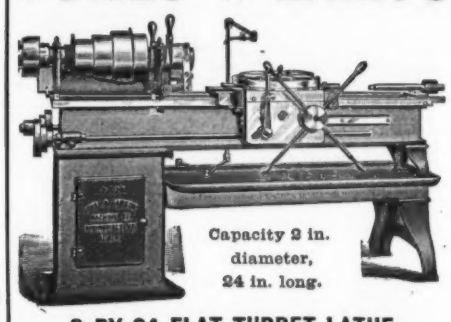

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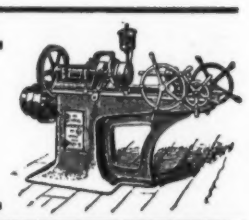

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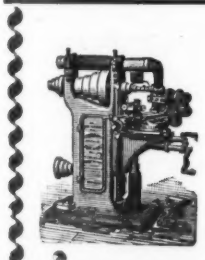

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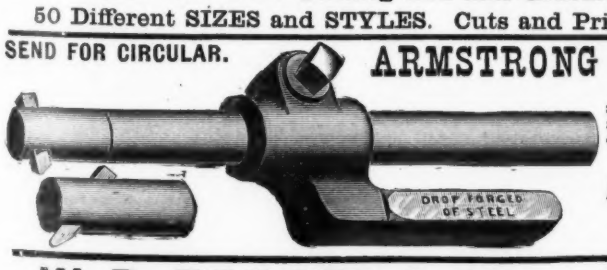

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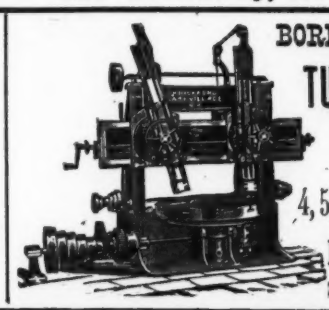

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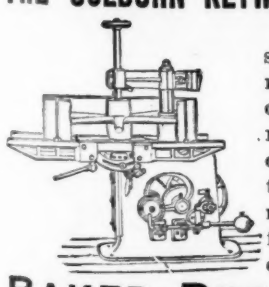

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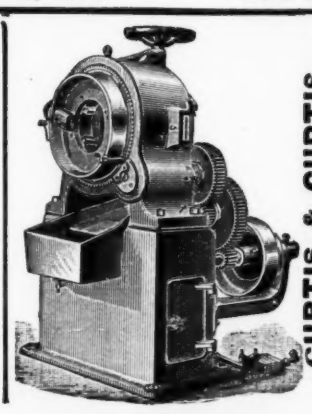

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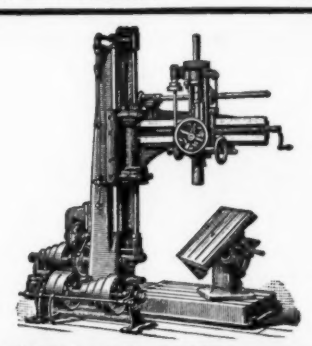

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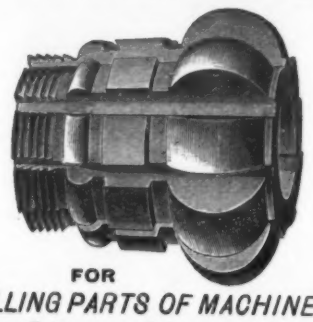

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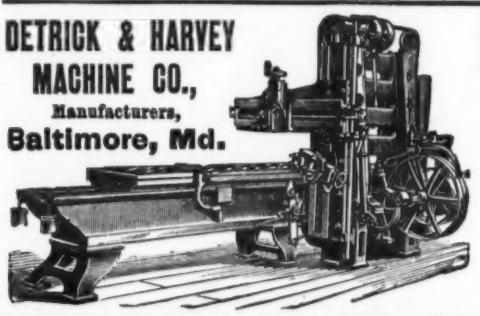

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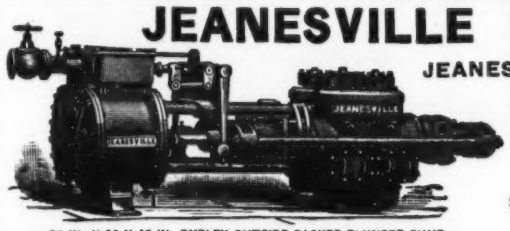

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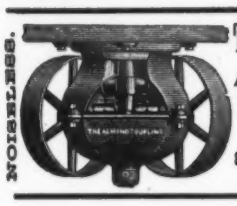

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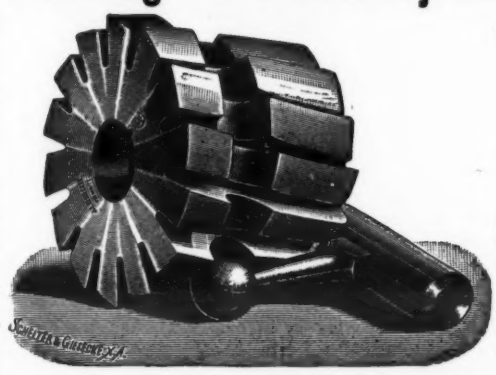

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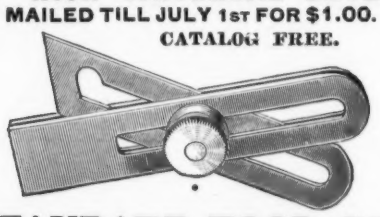

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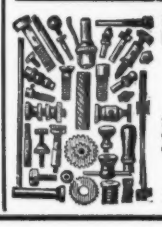

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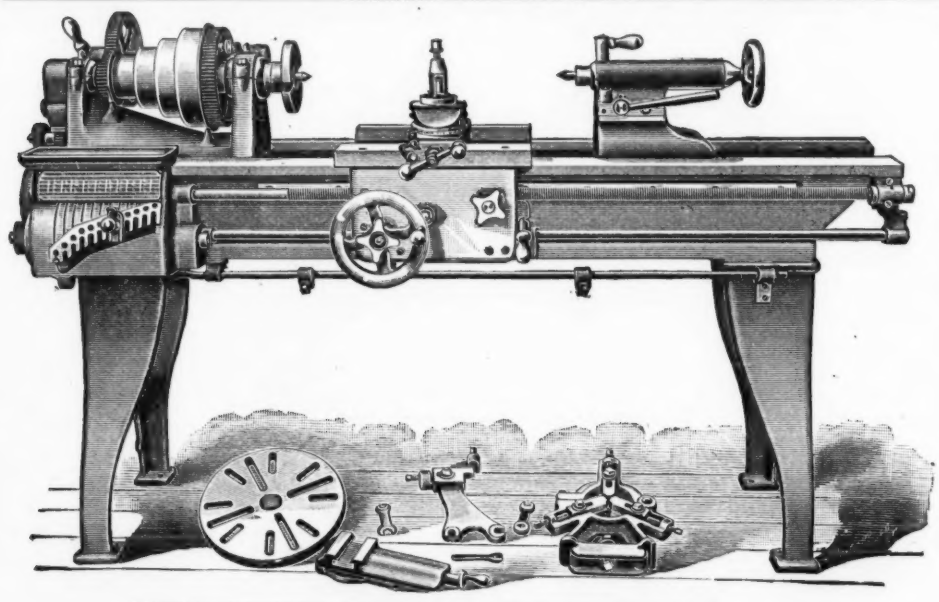

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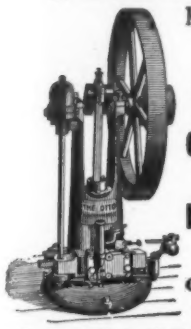

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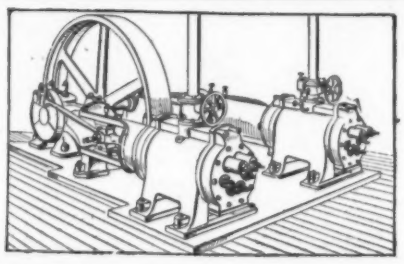

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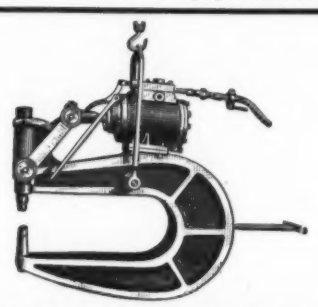

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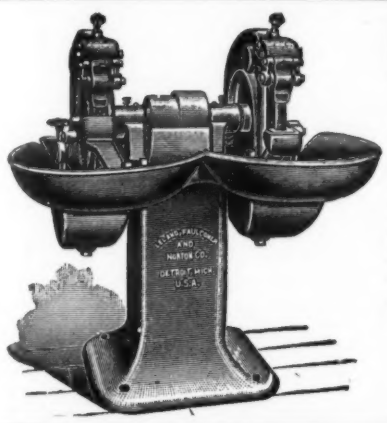

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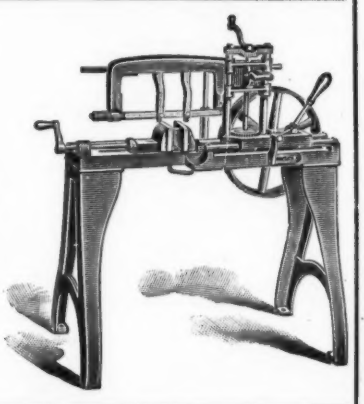

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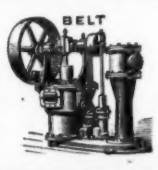

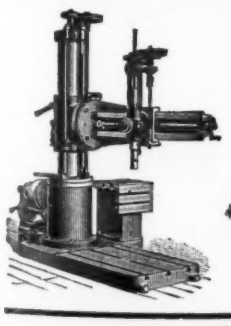

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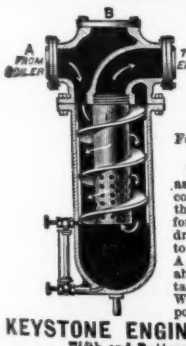

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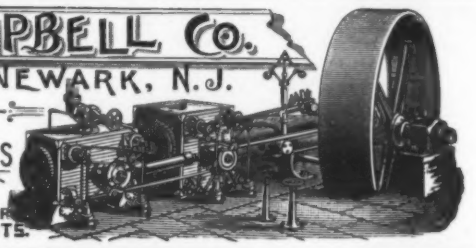

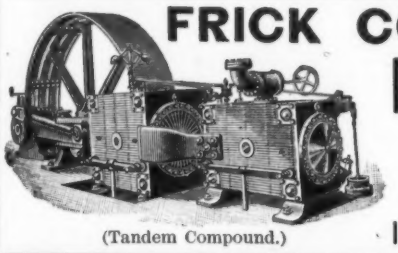

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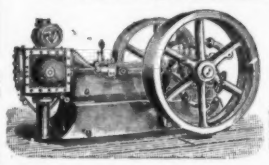

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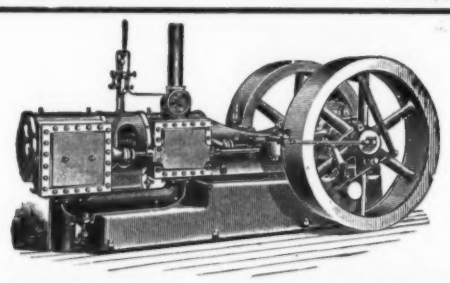

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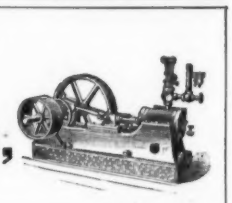

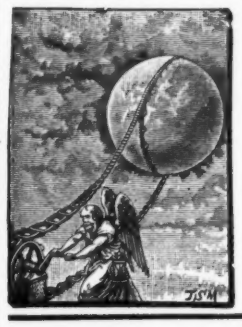

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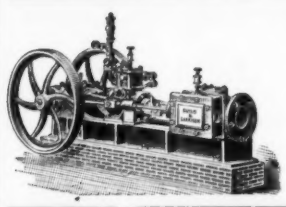

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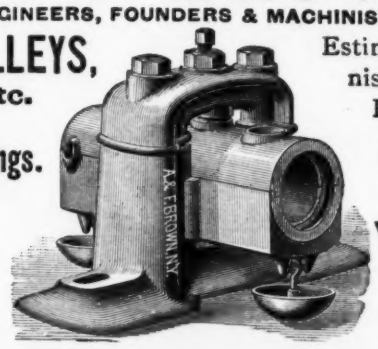

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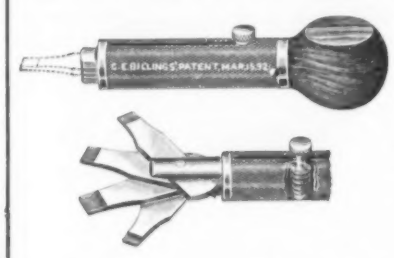

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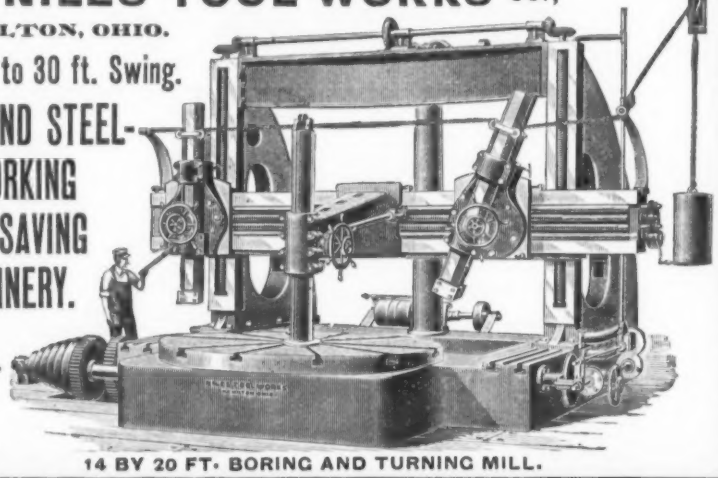

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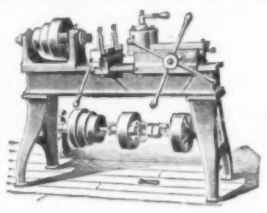

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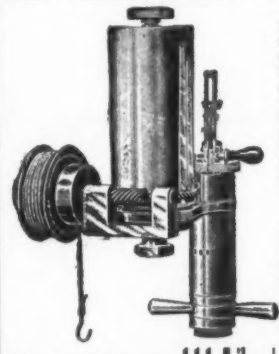

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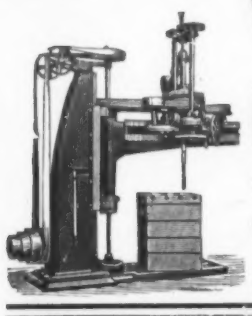

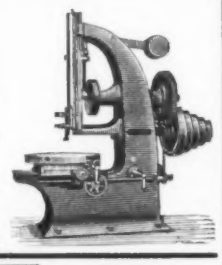

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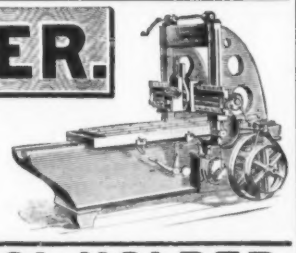

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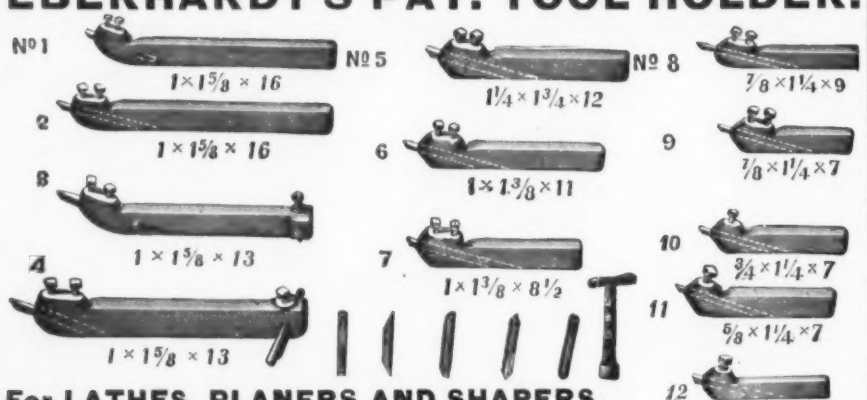

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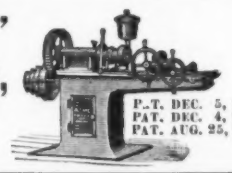

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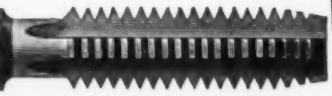

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